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Impact of surfactant depletion on foam in porous media

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WELCOME TO THE 7th BUBBLE & DROP EDITION

"Bubble & Drop" is a scientific convention which gathers together scientists, academic community, and industrial world around emulsion and foam research.

Conferences, scientific posters, industrial applications, all drops and bubbles aspects will rhythm the week to inspire, reveal, and make scientific research grow.

Created by Reinhard Miller (Max Planck Institute, Germany), Bubble & Drop is the scientific congress reference in Europe.

In 2017, Life Sciences will especially be in the spotlight: health, nutrition, personal and home care, environment…

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PLENARY SPEAKERS

Dr. Robert V. Farese and Dr. Tobias C. Walther, Harvard/Howard Hughes
Medical Institute, Boston, United States
"Droplets in Biology: The Cell Biology of Metabolic Energy Storage"

Dr. Robert Farese, Jr., studied chemistry at the University of Florida and medicine at Vanderbilt University. He then completed a residency and chief residency in internal medicine at the University of Colorado. In 1989, Dr. Farese moved to the University of California San Francisco to train in endocrinology and metabolism and did his postdoctoral research training with Dr. Stephen Young at the Gladstone Institutes, where he became an expert in gene targeting in murine embryonic stem cells and studied lipoprotein and cholesterol metabolism. In 1994, Dr. Farese established his laboratory at the Gladstone and UCSF where he studied neutral lipid metabolism, focusing on the pathways of lipid synthesis and storage. His laboratory cloned many of the important enzymes of neutral lipid synthesis, including the DGAT enzymes, which mediate triglyceride (TG) synthesis. Excessive accumulation of TGs underlies obesity, diabetes, fatty liver, and other metabolic diseases. Dr. Farese and co-workers discovered the DGAT enzymes and defined their molecular functions in lipid biochemistry, physiology, identified human disease mutations, and laid the groundwork for development of DGAT inhibitors.

In 2005, Dr. Farese took a sabbatical with Dr. Peter Walther, where he began working with Dr. Tobias Walther on the cell biology of lipid droplets. They collaborated closely for many years and established a joint laboratory at Harvard in 2014. They have focused on unraveling the molecular mechanisms of LD formation, protein targeting to LDs, and the role that LDs play in disease.

In 2007, Dr. Farese co-founded the Consortium for Frontotemporal Dementia (FTD) Research (CFR), a UCSF-based, multi-investigator collaborative effort whose goal is to find cures for FTD by studying progranulin biology. Dr. Farese and co-workers have generated murine and iPS models for progranulin-deficient FTD, and he co-directs the Basic Research for the CFR.

Dr. Farese has received numerous honors, among them election to the American Society for Clinical Investigation and the Association of American Physicians, a "Freedom to Discover Award" from Bristol-Myers Squibb, and the Avanti Lipid research award.

Presentation title:

The Phase of Fat: The Fascinating Biology of Lipid Droplets

PLENARY SPEAKERS

Prof. Dr. Tobias Walther is a German biochemist elucidating the mechanisms underlying lipid and membrane homeostasis. He is particularly interested in the processes of metabolic energy storage as fat in health and disease, for instance during obesity and the metabolic syndrome or in neurodegeneration. He received his Ph.D. from the European Molecular Biology Laboratory in Heidelberg in 2002, working on nuclear pores in Iain Mattaj's laboratory. He then trained with Prof. Dr. Peter Walter at the UCSF in San Francisco (CA, USA) where he studied membrane biochemistry and cell biology. In 2006, he started his laboratory first at the Max Planck Institute of Biochemistry (Germany) then Yale University (CT, USA). In July 2014, he moved to the Harvard School of Public Health and Medical School in Boston (MA, USA) where he runs a laboratory on metabolism research with his scientific partner Robert Farese, Jr.

Presentation title:

The Phase of Fat: The Fascinating Biology of Lipid Droplets

Dr. Jean-François Argillier, Institut Français du Pétrole Energies Nouvelles, Rueil-Malmaison, France
"Bubbles and drops in upstream oil applications"

Jean-François Argillier is IFP Energies Nouvelles Expert in Colloids & Interface Sciences. He is also project manager of EOR and water management. His research focuses on colloidal systems and complex fluids in oil applications, in particular, surfactants, polymers, asphaltenes, emulsions, foams, scales, encountered in enhanced oil recovery, water management and heavy oil production. Jean-Francois graduated from Ecole Supérieure de Physique et Chimie Industrielles de Paris (ESPCI) and holds a PhD from University Pierre et Marie Curie, Paris VI. (1989) in Chemical engineering (chemical EOR), followed by a postdoctoral position at the University of Minnesota (USA). He joined IFPEN in 1993.
He has been in charge of several collaborative research projects in different thematics over the years, drilling fluids, formation damage, heavy oil production, scale formation, water management and enhanced oil recovery. Jean-Francois is member of SPE and ACS and serves in different organizing committees (SPE Forum, Petrophase, World emulsion conference...). He is author of many publications and patents on colloidal systems in oil production.

Presentation title:

Bubble & drop in oil & gas upstream: some challenges

PLENARY SPEAKERS

Dr. Marta Krasowska, University of South Australia, Adelaide, Australia
"Bubbles rise and interaction with surfaces: from fundamentals to application"

Marta's research focuses on the interactions between soft and rigid interfaces, the physicochemical properties of such interfaces, and how that affects industrial processes. She uses techniques such as the AFM to probe forces between interfaces, coupled with profile analysis tensiometry and FTIR/QCM to characterise adsorption at those interfaces. The influence of adsorption/surface forces in macroscopic systems is probed via high speed video capture of bubble and droplet collisions.

She leads a team of six postdocs and six PhD students in this area, with funding from the Australian Government, and Australian and international industry.

Presentation title:

Bubbles rise and interaction with surfaces: from fundamentals to appli

Dr. Marie-Pierre Krafft, Institut Charles Sadron, Centre National de la Recherche Scientifique et Université de Strasbourg, France
"Fluorocarbons, Bubbles and Drops"

Marie Pierre Krafft is Research Director at the Charles Sadron Institute (CNRS), University of Strasbourg, has served in numerous national and international evaluation, recruitment and funding committees and review boards, meeting organization committees, and is a member of the International Scientific Comity for the Henri Moissan Prize. Her current research bears on the design, engineering and investigation of nano-compartmented, fluorocarbon-promoted molecular self-assemblies; fluorocarbon-based therapeutics, and active soft matter.

She has published over 130 papers, holds 10 patents, has given some 75 invited lectures in International Meetings, is a Section Editor for Curr. Opin. Colloid Interface Sci., received Awards from the Chemical Society of Japan and the French Académie des Sciences, and is currently an Invited Professor at Doshisha University (Kyoto, Japan). She is a Member of the European Academy of Sciences and of the Légion d'honneur.

Presentation title:

Fluorocarbons, Bubbles and Drops

PLENARY SPEAKERS

Dr. Peter Wierenga, Wageningen University, Wageningen, The Netherlands
"From molecular properties to functional properties: Protein stabilised foams and emulsions"

Dr. Peter Wierenga has graduated as a PhD in Food Chemistry at the Wageningen University. In this PhD study he has studied the role of protein molecular properties on the protein interfacial and foam properties.

After the PhD he has worked on different post-doc projects in food physics and food chemistry, at Wageningen University with part-time work at Sofia University in Bulgaria. Those projects were aimed at developing insight into the link between molecular properties of proteins and their techno-functional properties (i.e. foam, but also emulsions, and aggregation gelation). Since 2008 he works as assistant professor in the Laboratory of Food Chemistry, leading the research on protein (bio-) chemistry.

Title of presentation:

From molecular properties to functional properties: Protein stabilised foams and emulsions

MONDAY - *June 26th*

8.15 > 8.45 am	Registration
8.45 > 9.00 am	Opening by Dr. A. Cagna - Teclis Scientific
9.00 > 9.45 am	**PLENARY LECTURE**
	Dr. Marie-Pierre Krafft - France
9.45 > 10.15 am	Keynote / Thodoris Karapantsios
10.15 > 10.45 am	Coffee break
10.45 > 12.30 am	Talk Session

12.30 am > 2.00 pm	Lunch break
2.00 > 2.30 pm	Keynote / Victor Starov
2.30 > 3.45 pm	Talk Session
3.45 > 4.15 pm	Coffee break
4.15 > 5.00 pm	Talk Session
5.00 > 6.30 pm	Flash / Poster session
6.30 > 8.30 pm	**Welcome Cocktail**

TUESDAY - *June 27th*

8.15 > 8.45 am	Registration
8.45 > 9.30 am	**PLENARY LECTURE**
	Dr. Robert V. Farese, Dr Tobias C. Walther - US
9.30 > 10.00 am	Keynote / Laurent Joly
10.00 > 10.30 am	Talk Session
10.30 > 11.00 am	Coffee break

11.00 > 11.30 am	Keynote / Francesca Ravera
11.30 > 12.30 am	Talk Session
12.30 am > 2.00 pm	Lunch break
2.00 > 3.45 pm	Talk Session
3.45 > 4.15 pm	Coffee break
4.15 > 5.00 pm	Talk Session
5.00 > 6.30 pm	Poster session

WEDNESDAY- *June 28th*

8.15 > 8.45 am	Registration
8.45 > 9.30 am	**PLENARY LECTURE**
	Dr. Peter Wierenga - Netherlands
9.30 > 10.00 am	Keynote / Mickaël Antoni
10.00 > 10.30 am	Talk Session
10.30 > 11.00 am	Coffee break

11.00 > 12.30 am	Talk Session
12.30 am > 1.45 pm	Lunch break
1.45 > 2.15 pm	Keynote / Anaïs Benarouche
2.15 > 3.45 pm	Talk Session
3.45 > 4.15 pm	Coffee break
4.15 > 5.45 pm	Flash / Poster session
5.45 > 6.30 pm	**Visit of ILM**

THURSDAY- *June 29th*

8.15 > 8.45 am	Registration
8.45 > 9.30 am	**PLENARY LECTURE**
	Dr. Jean-François Argillier - France
9.30 > 10.00 am	Keynote / Hans Tromp
10.00 > 10.30 am	Talk Session
10.30 > 11.00 am	Coffee break

11.00 > 12.30 am	Talk Session
12.30 am > 1.45 pm	Lunch break
1.45 > 2.15 pm	Keynote / Emmanuelle Rio
2.15 > 3.30 pm	Poster session
3.30 > 4.00 pm	**Poster Awards**
8.00 > 11.15 pm	**Gala Dinner**

FRIDAY- *June 30th*

8.15 > 8.45 am	Registration
8.45 > 9.30 am	**PLENARY LECTURE**
	Dr. Marta Krasowska - Australia

9.30 > 10.30 am	Talk Session
10.30 > 11.00 am	Coffee break
11.00 > 12.00 am	Talk Session
12.00 > 12.30 am	Closing by Dr. A. Cagna - Teclis Scientific

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KEYNOTES & ORAL SESSIONS

MONDAY - *June 26th*

10.00 AM > KERBEROS: An innovative device for studying wetting/spreading/sliding under controlled body forces
Thodoris Karapantsios, *Department of Chemical Technology, Aristotle University of Thessaloniki, Greece*

11.00 AM > Turning metal-coated materials into superhydrophobic surfaces
Miguel Cabrerizo, *Faculty of Sciences, University of Granada, Spain*

11.15 AM > Bubbles motion and capture in water-saturated sands
Valerie Vidal, *Laboratoire de Physique, ENS Lyon – CNRS, France*

11.30 AM > effect of mixed cationic and non-ionic surface-active substances on kinetics of bubble attachment and quartz flotation
Agata Wiertel, *J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland*

11.45 AM > Electrowetting and dielectrowetting on lubricant impregnated /slip surfaces
Zuzana Brabcova, *Smart Materials and Surfaces Laboratory, Northumbria University, UK*

12.00 AM > An infrared study of the thermal contribution to Marangoni flows: new insights on the wine tears phenomenon
David Nieto, *Universite Libre de Bruxelles, Belgium*

12.15 AM > PMDS: a molecular coating that hides defects and slows drops
Eugene Choi, *Laboratoire de Physique Statistique, Ecole Normale Supérieure, UPMC , Paris, France*

2.00 PM > Free Drainage of non-newtonian Foams
Victor Starov, *Department of Chemical Engineering, Loughborough University, UK*

2.30 PM > New surfactant mixtures for fine foams with slowed drainage
Krastanka G. Marinova, *Dept. Chem. & Pharm. Eng., Fac. Chem. & Pharm., Sofia University, Bulgaria*

2.45 PM > Foam generation by snap-off due to flow across a sharp permeability transition
Swej Shah, *Delft University of Technology, Netherlands*

3.00 PM > Ultrasound transmission through model liquid foams
Lorene Champougny, *Gulliver, CNRS, ESPCI Paris, PSL Research University, France*

3.15 PM > Stable and easy biodegradable particle stabilized wet foams
Marcel Krzan, *J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland*

3.30 PM > FT-IR imaging spectroscopy investigations of spontaneous emulsification kinetics
Ritu Toor, *MADIREL, CNRS, Aix-Marseille Université, France*

4.15 PM > Particle foam flotation of nano-clay particles with bi-functional surfactant
Cyril Micheau, *Institut de Chimie Séparative de Marcoule, CEA, CNRS, UM, ENSCM, France*

4.30 PM > Emulsion Stabilized by Alpha-Gel in Glycerol Surfactant System
Yuji Yamashita, *Chiba Institute of Science, Japan*

4.45 PM > Study of factors influencing the formation of oil-in-water microemulsions
Saule Aidarova, *Kazakh National Research Technical University, Kazakhstan*

TUESDAY - *June 27th*

9.30 AM > Anomalous electro-osmosis in foam films
Laurent Joly, *Institut Lumière Matière, Université Claude Bernard Lyon 1-CNRS, France*

10.00 AM > Sulfonated methyl esters, linear alkylbenzene sulfonates and their mixed solutions: micellization and effect of Ca2+ ions
Rumyana Stanimirova, *Dept. Chem. & Pharm. Eng., Fac. Chem. & Pharm., Sofia University, Bulgaria*

10.15 AM > Design and characterization of soft nanostructures based on antennary oligoglycines
Elena Mileva, *Institute of Physical Chemistry, Bulgarian Academy of Science, Bulgaria*

11.00 AM > Titania and silica nanoparticles at water-air interfaces: properties of the mixed layers and application to foams and solid foams
Francesca Ravera, *CNR-Institute of Condensed Matter Chemistry and Technologies for Energy, Genoa, Italy*

11.30 AM > Tracking the surface composition of a covered air/liquid interface by non-linear optics
Oriane Bonhomme, *Institut Lumière Matière, Université Claude Bernard Lyon 1-CNRS, France*

11.45 AM > Particle raft as interfacial armour: effects of particle mobility and polydispersity
Carole Planchette, *Institute of Fluid Mechanics and Heat Transfer, Graz University of Technology, Austria*

12.00 AM > Surface tension, adsorption kinetics and dilational rheology studies by the drop profile analysis tensiometry
Reinhard Miller, *Max Planck Institute Colloids Interfaces, Germany*

12.15 AM > Ion-mediated interaction between nanoparticles at the oil-water interface
Boyao Wen, *State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, China*

2.00 PM > Dimple formation in asymmetric pseudo emulsion films
Alexander Wilsdorf, *NMI Natural and Medical Sciences Institute, University of Tübingen, Germany*

2.15 PM > The Relationship between Structure and Foaming Performance for a Range of Different Types of Chemical Surfactant
Robert Pugh, *School of Science and Technology, Nottingham Trent University, UK*

2.30 PM > Foams with fast and slow Ostwald ripening
Svenja Baessler, *KRÜSS GmbH, Hamburg, Germany*

2.45 PM > Study of Interfacial Properties To Anticipate Foaming Episodes In WWT
Manel Larachiche, *TIMR, Université de Technologie de Compiègne (UTC), Sorbonne Universités, France*

3.00 PM > Dynamics of a fibre-laden foam
Vincent Langlois, *Laboratoire de Géologie de Lyon, Université Claude Bernard Lyon 1, ENS-Lyon, CNRS, France*

3.15 PM > Encapsulation of vitamine E by water soluble polymer-surfactant mixtures
Altynay Sharipova, *Kazakh National Research Technical University, Kazakhstan*

3.30 PM > Emulsion morphology and dynamics by combined DWS and optical microscopy
Luigi Cristofolini, *Dept. of Mathematical, Physical and Computer Sciences, University of Parma & CNR-Institute of Condensed Matter Chemistry and Technologies for Energy, Genoa, Italy*

4.15 PM > Manipulation of the Electrically Charged Droplet
Stéphane Dorbolo, *GRASP, CESAM, Univ. Liège, Belgium*

4.30 PM > Bubble motion in aqueous solutions of simple alcohols - myths and reality
Pavlina Basarova, *University of Chemistry and Technology, Prague, Czech Rep.*

4.45 PM > Simulation and observation of line-slip structures in columnar structures of soft spheres
Benjamin Haffner, *School of Physics, Trinity College Dublin, The University of Dublin, Ireland*

WEDNESDAY- *June 28*[th]

9.30 AM > **2D simulation of interacting bubbles and droplets**
Mickaël Antoni, *MADIREL, CNRS, Aix-Marseille Université, France*

10.00 AM > Drop transport and positioning on lubricant impregnated surfaces
Jian Guan, *Smart Materials and Surfaces Laboratory, Northumbria University, UK*

10.15 AM > Rising bubble instabilities and fragmentation in a confined polymer solution
Raphaël Poryles, *Laboratoire de Physique, ENS Lyon – CNRS, France*

11.00 AM > Thermal Antibubbles
Laurent Maquet, *GRASP, CESAM, Univ. Liège, Belgium*

11.15 AM > Droplet based lenses actuated by laser-induced solutocapillary forces
Natalia Ivanova, *Tyumen State University, Photonics and Microfluidics Laboratory, Russia*

11.30 AM > Drop-to-bubble transition under acoustic levitation: a tornado in sound field
Duyang Zang, *Functional Soft Matter& Materials Group, School of Science, Northwestern Polytechnical University, Xi'an, China*

11.45 AM > Bubbles cavitation and propagation in micro-confined porous systems
Chiara Scognamiglio, *Laboratoire de physique de la matière condensée, Université Nice Sophia Antipolis, CNRS, France*

12.00 AM > Dynamics of 2D bubbles in a micrometric Hele-Shaw cell
Benjamin Reichert, *Gulliver, CNRS, ESPCI Paris, PSL Research University, France*

12.15 AM > Effect of inner phase on size distribution of bubble or drop breakup
Maria Zednikova, *Institute of Chemical Process Fundamentals, Prague, Czech Rep.*

1.45 PM > **Interfacial properties of NTAIL, an intrinsically disordered protein**
Anais Benarouche, *UMR 7282 Enzymologie Interfaciale et Physiologie de la Lipolyse, CNRS, Aix-Marseille Université, & TECLIS Scientific, Tassin, France*

2.15 PM > Stimulable, Stable and Biocompatible W/O/W Emulsions for Encapsulation and controlled Delivery of Drugs
Noémie Bodin, *LIONS, NIMBE, CEA, CNRS, Université Paris-Saclay, CEA Saclay & Institut Galien Paris-Sud, CNRS, Châtenay-Malabry & SIMM, ESPCI, Paris, France*

2.30 PM > Growth and Stability of bubbles in an oversaturated liquid
Jonas Miguet, *Laboratoire de Physique des Solides, Université Paris Sud 11-CNRS, France*

2.45 PM > The effect of serum proteins on the dynamic interfacial properties of high-viscosity silicone oils
Eva Santini, *CNR-Institute of Condensed Matter Chemistry and Technologies for Energy, Genoa, Italy*

3.00 PM > Dynamic properties of DNA/Surfactant Adsorption Layer
Boris A. Noskov, *St.Petersburg State University, Russia*

3.15 PM > Effect of cholesterol on liposome membrane permeability: application to corticoids
Samar Kaddah, *Faculty of Sciences, Lebanese University & LAGEP, Université Claude Bernard Lyon 1, CNRS, France*

3.30 PM > Voltage sensitive second harmonic generation in lipid bilayers
Yovan De Coene, *KU Leuven, Belgium*

THURSDAY - *June 29th*

9.30 AM > Water-water interfaces
Hans Tromp, *NIZO food research & Van't Hoff Laboratory for Physical and Colloid Chemistry, Utrecht University, The Netherlands*

10.00 AM > Numerical simulations of the hydrodynamic behaviour of a molten Metal-Gas-Oxide model system
Sergey Semenov, *MADIREL, CNRS, Aix-Marseille Université, France*

10.15 AM > Flow Regime Identification with Fast Electrical Impedance Tomography
Antoine Dupre, *CEA Cadarache, France*

11.00 AM > Dispersed bubbles for soil flotation in continuous column
Anouar Ben Said , *CEA, DEN, DE2D, SEAD, Supercritical Processes and Decontamination Laboratory (LPSD), Marcoule, France*

11.15 AM > Influence of Bubble size on reactive mass transfer at sigle free-rising bubbles: a numerical analysis of mass transfer coefficient and selectivity
Manuel Falcone, *Thermo-Fluids & Interfaces, Technical University of Darmstadt, Germany*

11.30 AM > Innovative process for precise size control of emulsion production at pilot scale
Océane Alliod, *LAGEP, Université Claude Bernard Lyon 1, CNRS, France*

11.45 AM > Coffee ring effect on porous substrates
Abhijeet Kumar, *1) Institute of Technical Thermodynamics and Center of Smart Interfaces, Technische Universität Darmstadt, Germany*

12.00 AM > Breathing surfactant droplets caused by the cyclically changed humidity of air
Nikolay Kubochkin, *Tyumen State University, Photonics and Microfluidics Laboratory, Russia*

12.15 AM > Dewetting from a Liquid Film into a Single Droplet
Carl Brown, *School of Science and Technology, Nottingham Trent University, UK*

1.45 PM > a two-bubble experiment to investigate grain growth in the presence of surface elasticity
Emmanuelle Rio, *Laboratoire de Physique des Solides, Université Paris Sud 11-CNRS, France*

FRIDAY - *June 30th*

9.30 AM > Simulations of Sheared Bubbles with surfactants-laden interfaces
Marie Le Merrer, *Institut Lumière Matière, CNRS-Université Claude Bernard Lyon 1, France*

9.45 AM > Dodecane in water emulsions stabilized by sds: adsorption properties and emulsion behaviour
Sara Llamas, *CNR-Institute of Condensed Matter Chemistry and Technologies for Energy, Genoa, Italy*

10.00 AM > Coarsening and coalescences of a liquid 2D-Foam
Emilie Forel, *Laboratoire de Physique des Solides, Université Paris Sud 11-CNRS, France*

10.15 AM > Ultrastable and stimulable foam from surfactant crystals
Anniina Salonen, *Laboratoire de Physique des Solides, Université Paris Sud 11-CNRS, France*

11.00 AM > Foam drying under microgravity conditions
Anna Trybala, *Department of Chemical Engineering, Loughborough University, UK*

11.15 AM > The mechanism behind the cell-opening of polyurethane foams
Aouatef Testouri, *Institut Charles Sadron - Strasbourg , France*

11.30 AM > Foamed emulsion drainage: flow and trapping of drops
Maxime Schneider, *Laboratoire de Physique des Solides, Université Paris Sud 11-CNRS, France*

11.45 AM > Rheology in Particulate Systems
Matthias Sperl, *Institute of Materials Physics in Space, Cologne, Germany*

12.15 AM > Non-linear surface rheology of spread monolayers of lung phospholipids
Aleksei Bykov, *St. Petersburg State University, Russia*

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SUMMARY

KEYNOTE

Victor	Starov
Hans	Tromp
Mickaël	Antoni
Laurent	Joly
Emmanuelle	Rio
Francesca	Ravera
Thodoris	Karapantsios
Anaïs	Benarouche

TALK

Boris A.	Noskov
Krastanka G.	Marinova
Sergey	Semenov
Stéphane	Dorbolo
Aleksei	Bykov
Pavlina	Basarova
Noémie	Bodin
Lorene	Champougny
Manel	Larachiche
Marie	Le Merrer
Ritu	Toor
Alexander	Wilsdorf
Cyril	Micheau
Valerie	Vidal
Raphaël	Poryles
Miguel	Cabrerizo
Antoine	Dupre
Rumyana	Stanimirova
Elena	Mileva
Robert	Pugh
Svenja	Baessler
Jonas	Miguet
Benjamin	Haffner
Maxime	Schneider
Anniina	Salonen
David	Nieto
Natalia	Ivanova

Nikolay	Kubochkin
Carl	Brown
Reinhard	Miller
Duyang	Zang
Boyao	Wen
Aouatef	Testouri
Chiara	Scognamiglio
Eva	Santini
Agata	Wiertel
Sara	Llamas
Emilie	Forel
Luigi	Cristofolini
Benjamin	Reichert
Maria	Zednikova
Anouar	Ben Said
Vincent	Langlois
Laurent	Maquet
Eugene	Choi
Matthias	Sperl
Altynay	Sharipova
Océane	Alliod
Manuel	Falcone
Jian	Guan
Zuzana	Brabcova
Saule	Aidarova
Anna	Trybala
Swej	Shah
Oriane	Bonhomme
Abhijeet	Kumar
Samar	Kaddah
Marcel	Krzan
Yovan	De Coene
Carole	Planchette
Yuji	Yamashita

POSTER SESSION A (MONDAY-TUESDAY)

A01: Effect of surfactant and WSP concentration on the size of sulfur nanoparticles
Saule Aidarova, Kazakh National Research Technical University, Kazakhstan

A02: Impact study of contact angle boundary conditions for CFD simulation of two-phase flow generation in a T-junction
Santiago Arias, Universitat Politècnica de Catalunya, Spain

A03: Droplet jetting on porous surfaces
Amir Ashrafi, Chair of Building Physics, Department of Mechanical and Process Engineering, ETH Zurich, Switzerland

A04: Experimental study of a bubble flow of an air-lift under vacuum
Hassan Barkai, LMFA-INSA de Lyon Univ. Lyon 1 CNRS, France

A05: Electrical charging of bouncing droplets
Pierre-Brice Bintein, CESAM-GRASP, Univ. Liège, Belgium

A06: Drainage and rupture dynamics of egg white albumen pendant bubbles
Wei Chen, Okinawa Institute of Science and Technology Graduate University, Japan

A07: Effect of particule size and surface hydrophobicity on self-pinning behavior of nanofluid droplets
Li-Jen Chen, Department of Chemical Engineering, National Taiwan University, Taiwan

A08: Experimental determination of the ambient pressure through the resonance frequency of bubbles immersed in a gel
Judith Cueto Fernández, Fluid Mechanics Group, Universidad Carlos III de Madrid, Spain

A09: Foam acoustics: focus on the vibrations at the bubble scale
Caroline Derec, Laboratoire Matière et Systèmes Complexes (MSC), Univ. Paris-Diderot - CNRS, France

A10: Gas Well Deliquification foamers for high temperature and high salinity conditions
Maxime Feche, Stepan Europe, Voreppe, France

A11: Laser manipulator for liquid droplets: automated dosing and transport
Victor Flyagin, Tyumen State University, Photonics and Microfluidics Laboratory, Russia

A12: Laser induces thermocapillary oscillations in liquid-liquid systems
Natalia Ivanova, Tyumen State University, Photonics and Microfluidics Laboratory, Russia

A13: Growing drop experiments with surfactant solutions
Talmira Kairaliyeva, Max Planck Institute Colloids Interfaces, Germany & Kazakh National Research Technical University, Kazakhstan

A14: Catastrophic Phase Inversion to Produce Stable Emulsions at Low Energy
Thodoris Karapantsios, Department of Chemical Technology, Aristotle University of Thessaloniki, Greece

A15: Influence of wake presence on bubble acceleration and local velocities
Marcel Krzan, J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland

A16: Stability of whey protein wet foams generated in double-syringe device
Marcel Krzan, J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland

A17: Microstreaming induced by non-spherical bubble oscillations
Cyril Mauger, LMFA-INSA de Lyon Univ. Lyon 1 CNRS, France

A18: Dynamics of contact line pinning and depinning during droplet evaporation on hydrophylic micro- pillar arrays
Ali Mazloomi, Chair of Building Physics, Department of Mechanical and Process Engineering, ETH Zurich, Switzerland

A19: Influence of surfactants and gas properties for the preparation of microbubbles by membranes
Romain Melich, LAGEP, Université Claude Bernard Lyon 1, CNRS & LabTAU, INSERM, Université Lyon 1, France

A20: Study of Chitosan-Alginate microcapsules with encapsulated hydrophilic drugs
Reinhard Miller, Max Planck Institute Colloids Interfaces, Germany

A21: Freezing and melting of water droplets on heated super-hydrophobic porous surfaces
Stella Ramos-Canut, Institut Lumière Matière, Université Claude Bernard Lyon 1-CNRS, France

A22: Dynamics of a train of bubbles in a microchannel
Javier Rivero-Rodriguez, TIPs - Université Libre de Bruxelles, Belgium

A23: Adsorption of triclosan as model system for waste water treatment by the mineral sorbent diatomite
Altynay Sharipova, Kazakh National Research Technical University, Kazakhstan

A24: Capillary Penetration into Inclined Circular Glass Tub
Christophe Trabi, School of Science and Technology, Nottingham Trent University, UK

A25: Breakup of bubbles in a turbulent flow: number of daughter particles and their size distribution
Jiri Vejrazka, Institute of Chemical Process Fundamentals, Prague, Czech Rep.

A26: Application of 3D clinostat for evaluation of emulsion stability
Yuji Yamashita, Chiba Institute of Science, Japan

A27: Automatic single bubble generator with adsorption time control
Jan Zawala, J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland

POSTER SESSION B (WEDNESDAY-THURSDAY)

B01: *Influence of polymer-surfactant compositions adsorption on process of clearing of oil emulsion from water and salts*
Saule Aidarova, Kazakh National Research Technical University, Kazakhstan

B02: *Viscoelastic properties of novel thermo-viscosifying polymer*
Saule Aidarova, Kazakh National Research Technical University, Kazakhstan

B03: *Impact of Viscous Drops on Soft Substrates*
Ehsanul Alam, Institute of Technical Thermodynamics, TU Darmstadt, Germany

B04: *Stabilization of foams by mixtures of high-molecular natural surfactants*
Fariza Amankeldi, Faculty of Chemistry and Chemical Technology, Al-Farabi Kazakh National University, Almaty, Kazakhstan

B05: *Firefighting foams*
Joris Arnault, BioEx, Montrottier & LAGEP, Université Claude Bernard Lyon 1, CNRS, France

B06: *Detail study of bubble adhesion dynamics in aqueous solution of surface active agents*
Pavlina Basarova, University of Chemistry and Technology, Prague, Czech Rep.

B07: *Interactions of foams with porous material under microgravity conditions*
Jennifer Cook, Department of Chemical Engineering, Loughborough University, UK

B08: *EMULSION STABILITY AND DROP SIZE DISTRIBUTION*
Luigi Cristofolini, Dept. of Mathematical, Physical and Computer Sciences, University of Parma & CNR-Institute of Condensed Matter Chemistry and Technologies for Energy, Genoa, Italy

B09: *Mass Transfer with slender drops in a nonlinear extensional flow*
Moshe Favelukis, Shenkar - College of Engineering and Design, Ramat-Gan, Israel

B10: *Structured surfactant liquids technology: novel suspensive system by surfactant self-assembly*
Maxime Feche, Stepan Europe, Voreppe, France

B11: *Facile method for the production of lubricant impregnated surfaces on complex geometries* Nicasio Geraldi, Smart Materials and Surfaces Lab, Faculty of Engineering and Environment, Northumbria University, UK

B12: *Impact of surfactant depletion on foam in porous media*
Ahmed Hussain, Delft University of Technology, The Netherlands

B13: *Electroosmosis in free liquid film for the purpose of modelling flow in foam plateau borders and liquid lamella*
Abdulkadir Hussein-Sheik, Department of Chemical Engineering, Loughborough University, UK

B14: *Micromixing in evaporating droplets caused by festoon instability*
Natalia Ivanova, Tyumen State University, Photonics and Microfluidics Laboratory, Russia

B15: *Influence of n-alkanol chain length on acceleration, local and terminal velocities of bubbles*
Marcel Krzan, J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland

B16: *Studies on hydrogel matrices based on polysaccharides*
Marcel Krzan, J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland

B17: *Neutron reflection study of mixed silica nanoparticle-CTAB layers at the water/dodecane interface*
Libero Liggieri, CNR – Inst. for Condensed Matter Chemistry and Energy Technologies, Genoa, Italy

B18: Adsorption layer dynamics at the aqueous-solution/hydrocarbon interface: Oscillating Drop Capillary Pressure experiments under low gravity conditions
Libero Liggieri, CNR – Inst. for Condensed Matter Chemistry and Energy Technologies, Genoa, Italy

B19: Observation of CO_2 micro-bubble dissolution by digital in-line holography
Cyril Mauger, LMFA-INSA de Lyon Univ. Lyon 1 CNRS, France

B20: Bulk and interfacial flows in the coalescence of surfactant-laden and surfactant-free drops
Emilia Nowak, Massey University, Auckland, New Zealand & University of Birmingham, UK

B21: Wetting dynamics of nanodroplets on vibrating surfaces
Rohit Pillai, School of Engineering, University of Edinburgh, UK

B22: Heat of Bubble Formation and Surface Pressure
Pablo Garrido, Soft Matter & Molecular Biophysics Group, Departamento de Física Aplicada, Facultade de Física, Universidade de Santiago de Compostela, Spain

B23: Second Harmonic Generation from soapy interfaces
Lucile Sanchez, Institut Lumière Matière, Université Claude Bernard Lyon 1-CNRS, France

B24: Contact Angles of Fat Crystals Determined by Atomic Force Microscopy Imaging
Damien Sebben, Future Industries Institute, University of South Australia

B25: Competitive adsorption of Triclosan and its derivatives from mixed model systems in waste water treatment by the sorbents
Altynay Sharipova, Kazakh National Research Technical University, Kazakhstan

B26: Water vapor condensation on ice
Ruddy Urbina, Universidad de Navarra, Complex Systems Group & PHYSMED Group, Pamplona, Spain

B27: Surface activity of cleavable amidequats
Piotr Warszyński, J. Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, Poland

Motion of a spherical drop with insoluble surfactant in microfluidic channel
Zhengyuan Luo, State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, China

AMPHIPHOBIC COATINGS FOR ANTIFOULING IN SEAWATER ENVIRONMENT
 Libero Liggieri, CNR-ICMATE Institute for Condensed Matter Chemistry and Technologies for Energy, Italy

KEYNOTE

Free Drainage of non-newtonian Foams

Victor, Starov

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Keywords: Foam, drainage, non-Newtonian

A recently proposed type of these situations is foam drainage placed on a porous substrate [1, 2] where foam is in contact with a porous substrate results in an imbibition of liquid from foam into the unsaturated pores.

Foams are conventionally stabilised by surfactants; however, polymers (polyelectrolytes) grow in popularity during the last decade as alternative stabilising additives to foaming solutions. Previously [3, 4] the influence of rheology of commercially available polymers AculynTM22 (A22) and AculynTM33 (A33) on foam drainage was investigated experimentally and the results of the properties modification of A22 and A33 polymeric solutions were presented. Here a theory of foam drainage is presented for the non-Newtonian polymeric solutions in the case of free drainage and its results are compared with experimental data. The equations of drainage have been deduced are solved, which showed that the decrease in the foam height and liquid content is very fast in the very beginning of the drainage; however, it reaches a steady state at long times (Fig. 1). Under the assumption of rigid surface of the Plateau border, the predicted values of the time evolution of the foam height and liquid content are in good agreement with the measured experimental data for lowly viscous polymeric solutions. However, in the case of highly viscous solutions an interfacial mobility at the surface of the Plateau border has to be taken into account.
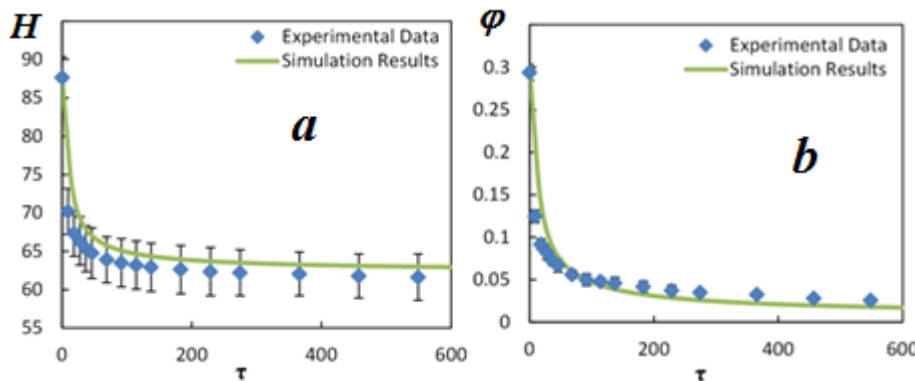

Fig. 1. Comparison of the predicted and experimental time evolution of a) the dimensionless height of the foam, $\zeta_2 - \zeta_1$, and b) the average liquid volume fraction along the foam height, φ, for A33_1.0% solution.

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Water-water interfaces

Hans Tromp[1,2]

Ben H. Erné[2], M. Vis[3]

Interfaces between phases of coexisting thermodynamically incompatible aqueous solutions are called water-water (w/w) interfaces. Their most common occurrence is between phase separated aqueous polymer solutions, such as solutions containing polysaccharides and proteins in food systems [Vis et al 2016]. Their industrial relevance lies in the fact that water-in-water emulsions provide low calorie alternatives to oil-containing emulsions. The tension of water-water interfaces is extremely low, i.e. typically a few µN/m or less. A difference from interfaces between phase separated blends, without solvent, arises from the accumulation of solvent at the interface. This accumulation of solvent at the interface lowers the interfacial tension.

Because of the low interfacial tension w/w interfaces are highly deformable and difficult to investigate by classical methods (e.g. the Wihelmy plate method). Water, salt and, in the case of polydisperse polymers, low molar mass fractions of the polymers can freely diffuse across the interface.

An extra dimension of w/w interfaces (as compared to other solvent/solvent interfaces) is possibility of Donnan potentials across the interface, due to their permeability for salts.

The experimental study of w/w interfaces will be reviewed, with particular attention to Donnan potentials, adsorption of particles and molecules at the w/w interface and the response to shear of water-in-water emulsions.

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A M. Vis, B. H. Erné, and R. H. Tromp, Chemical physics of water–water interfaces, Biointerphases 11, 018904–9 (2016)

2D simulation of interacting bubbles and droplets

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S. Semenov, R. Denoyel

A two-dimensional model of air bubbles interacting with water droplets in a paraffin oil continuous phase is proposed. Droplets and bubbles are subject to gravity and conditions are isothermal. Time evolution of this system is simulated for different initial conditions.

This system is a typical example of multiphase, unsteady, free interface problem known to raise challenging questions regarding to numerical stability. Here a home-made multiphase volume of fluid (VOF) code is employed [1-2]. It solves the continuity and Navier-Stokes equations for an incompressible medium along with the advection equation for color functions. In VOF different immiscible fluids are treated as a unique continuous phase but with changing material properties (density and viscosity) according to the local value of the color functions. The interfacial stresses are directly included into Navier-Stokes equations in form of an equivalent body force according to the continuous approach of Brackbill [3]. Interfacial curvature is computed with the aid of height-function [4]. The numerical scheme is based on 2nd order discretization in both time and space. The finite volume method on a staggered computational mesh is used for spatial discretization of all the equations. Three-phase interactions as well as wetting phenomena are included in the algorithms. The figure shows the time evolution of one bubble (orange) and two droplets (black). The size of the simulation domain is 5cm×5cm and the initial radius of both bubble and droplets is 5 mm. Due to their proximity, droplets coalesce in a larger drop right after simulation was started. It settles while bubble rises. Capillary numbers are large in this problem. This is why both bubble and droplet get deformed and even split when coming in contact. This occurs for the droplet at time t=0.45 s.

t = 0.00 s   t = 0.15 s   t = 0.25 s   t = 0.45 s
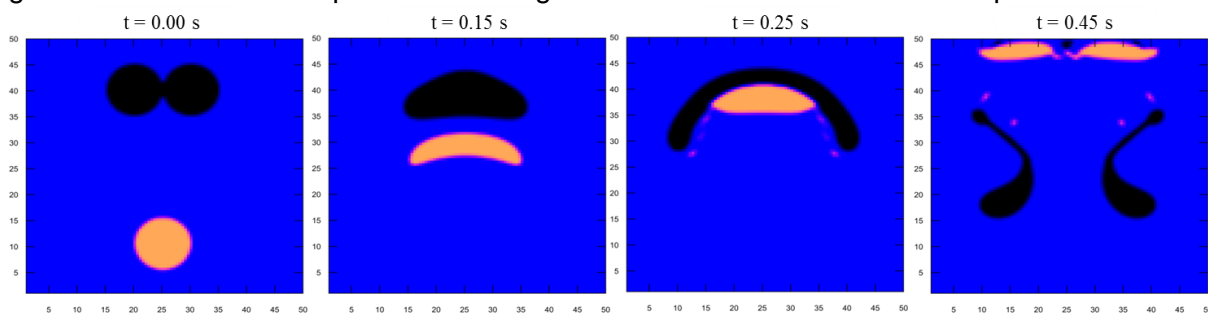
The model investigated here includes capillarity and wetting phenomena. Despite its 2D geometry, this model illustrates the accuracy level that can be reached with three phase VOF numerical techniques.

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Anomalous electro-osmosis in foam films

Laurent Joly[1]

A. Barbosa de Lima[1], B. Blanc[1], C. Ybert[1], F. Detcheverry[1], A.-L. Biance[1]

Electro-osmosis (EO) is a powerful tool to manipulate liquids in micro and nanofluidic systems. While EO has been studied extensively at liquid-solid interfaces, the case of liquidvapor interfaces, found e.g. in foam films and bubbles, remains largely unexplored. In Lyon, we are combining experiments [1] and simulations [2-4] to understand and optimize EO at the different scales of liquid foams. In particular, during this talk I will present recent numerical work on EO in foam films [2,3], and on bubble electrophoresis [4].
I will first present a molecular level investigation of EO in a liquid film covered with ionic surfactants. For rigid surfactants, we find that the zeta potential, quantifying the amplitude of EO, depends on the surfactant coverage in an unexpected way [2]. First, it increases upon lowering surfactant coverage from saturation. Second, it does not vanish in the limit of low coverage but instead approaches a finite value. This behaviour is rationalized by taking into account the key role of interfacial hydrodynamics, together with an ion-binding mechanism. We point out implications of these results for the strongly debated measurements of the zeta potential at free interfaces and for electrokinetic transport in liquid foams. For fluid surfactants, we show that the zeta potential can be smaller or larger than existing predictions depending on the surfactant coverage [3]. We explain the failure of previous descriptions by the fact that surfactants and bound ions move as rigid bodies and do not transmit the electric driving force to the liquid locally. Considering the reciprocal streaming current effect, we then develop an extended model, which can be used to predict the experimental zeta potential of surfactantladen liquid-gas interfaces.
Finally, I will briefly describe a recent work where we simulated the electrophoresis of bubbles in salty solutions, as a first step toward exploring larger scales of foams, and in order to investigate the role of the foam film boundaries [4].

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Keywords: electro-osmosis, zeta potential, molecular dynamics

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[3] A. Barbosa de Lima, L. Joly, submitted

[4] B. Blanc, C. Ybert, A.-L. Biance, L. Joly, in preparation

A two-bubble experiment to investigate grain growth in the presence of surface elasticity

Emmanuelle Rio[1]

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Foams and emulsions like many two-phase materials suffer from coarsening due to the energy cost, which is associated with the interface that separates both phases. While our understanding of the driving forces and the dynamics of coarsening in different materials is well advanced by now, current research efforts address the question of how this process may be slowed down, or, ideally, arrested [1].

Many systems including particles have proved very efficient to stabilize foams and/or emulsions against coarsening. Moreover many studies have questioned the Gibbs criterion, which predicts that coarsening stops if the surface elasticity is larger than half the surface tension [2].
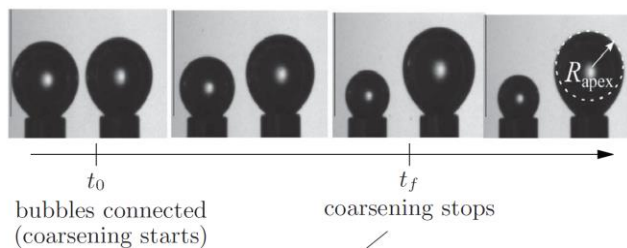
Figure 1: Two-bubble experiment in which the coarsening stops after some time.

In this work, we use a model experiment of two bubbles to explore how the presence of a finite surface elasticity may stop the coarsening process (Fig). Combining experiments and modelling in the analysis of the evolution of two bubbles, we show that clear relationships can be predicted between the surface tension, the surface elasticity and the initial/final size ratio of the bubbles [3]. We rationalise these relationships by the introduction of a modified Gibbs criterion. We also present perspectives to predict the coarsening dynamics of two bubbles by introducing surface viscosity. Besides their general interest, the present results have direct implications for our understanding of foam stability.

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Keywords: Coarsening, Bubbles, Surface elasticitypotential, molecular dynamic

References:

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Titania and silica nanoparticles at water-air interfaces: properties of the mixed layers and application to foams and solid foams

Francesca, Ravera

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Keywords: surface properties, particle-stabilized foams, solid foams

Solid nanoparticles (NPs) dispersed in aqueous media have been widely employed as stabilizers of foams and emulsions. Depending on their composition, surface charge, morphology, size and, in many cases, in association with specific surfactants, NPs assume adequate amphiphilic properties, which favour their transfer to the liquid interfaces [1, 2]. Particle stabilized foams, due to their properties related to the control of stability and morphology, have been also used for the fabrication of porous materials with tailored structural properties [3].

Titanium dioxide (TiO_2) is widely used in many technological fields, due to its important optical feature like, for example, photocatalytic properties and UV resistance.

In this work, we investigate the surface properties of TiO_2 aqueous dispersions, associated to short chain ionic surfactants. The obtained results, crossed with those by bulk characterization via Dynamic Light Scattering (DLS) and ζ-potential measurements, have allowed the definition of the best conditions favouring particles transfer to the liquid-air interfaces, so providing stable foams, suitable for further processing. Furthermore, we carry out the same study adding to the TiO_2 dispersion given amounts of SiO_2 nanoparticles.

The particle-stabilized foams obtained with this system are analysed against the dispersion composition as also the solid foams obtained adopting the method described in ref. 3.

The use of mixtures of nanoparticles of different chemical compositions to generate and stabilize foams is a rather innovative research topic. In particular, the TiO_2 - SiO_2 association, looks very promising for the application to the production of solid foams with specific functional properties.

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# KERBEROS: An innovative device for studying wetting/spreading/sliding under controlled body forces

Thodoris, Karapantsios[1]

Rios-Lopez[1], S. Evgenidis[1],
M. Kostoglou[1], X. Zabulis[2]

KERBEROS, is an novel device that can characterize wetting/spreading/sliding of droplets on solid substrates under the influence of controlled body forces. *KERBEROS* offers two unique features: (a) possibility of simultaneous rotation and tilting of the solid substrate in a broad range of rotation/tilting speed, and (b) recording the droplet from X-Y-Z directions using three Wi-Fi cameras that follow the rotation/tilting motion. The above features permit the independent control of normal and tangential forces applied to the droplet and allow 3D image reconstruction of the droplet shape. Advanced image analysis is employed for the extraction of 2D droplet contours versus time. Contours from all three views are combined to extract a 3D reconstruction of the droplet surface versus time. Contact angles along with other droplet geometrical characteristics are estimated. By differentiation, motion characteristics such as spreading/sliding velocity and rate of contact angle change, are also extracted. A supporting theoretical model for the equilibrium droplet shape has been developed. The model is based on a linearized two dimensional approximation and is actually the only one capable of giving closed form results. At first, the limiting cases of only normal and only tangential force are considered. Then the significance of non-constant force along the droplet is examined using the model. Based on the previous results the model is generalized to account for simultaneous variation of both force components. Interesting behavior like history-dependent droplet profile evolution and traverse motion under oscillating applied forces are observed.
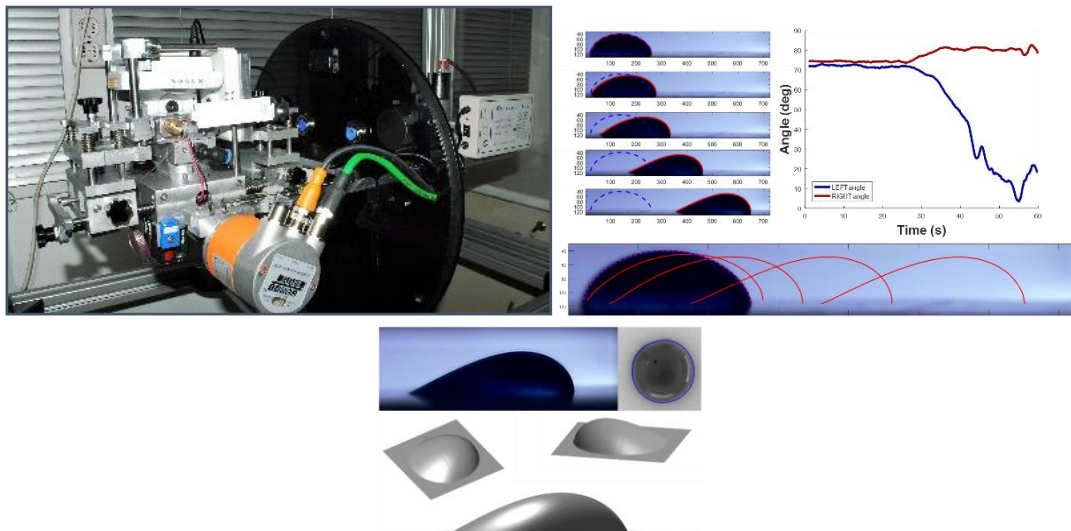
KERBEROS device and representative 2D data and 3D reconstructed images

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Keywords: wetting, spreading, sliding

Interfacial properties of N$_{TAIL}$, an intrinsically disordered protein

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Intrinsically disordered proteins (IDPs) lack stable secondary and tertiary structures under physiological conditions in the absence of their biological partners and thus exist as dynamic ensembles of interconverting conformers, often highly soluble in water [1]. Some IDPs involved in neurodegenerative diseases can however restructure or form high-order protein aggregates and their aggregation process may be triggered by interaction with membranes. While the interfacial behaviour of globular proteins has been extensively studied, experimental data on IDPs at the air/water and water/lipid interfaces are scarce. We studied here the intrinsically disordered C-terminal domain of the Hendra virus nucleoprotein (NTAIL) [2] and compared its interfacial properties to those of lysozyme taken as a model globular protein of similar molecular mass. Adsorption of NTAIL at the air-water interface was studied in the absence and presence of phospholipids using the monomolecular film technique, polarization modulated-infrared reflection–absorption spectroscopy (PM-IRRAS) and an automated drop tensiometer for interfacial tension and elastic modulus determination with oscillating bubbles. All approaches showed a better adsorption capacity of NTAIL at the air-water interface compared to lysozyme. In the presence of phospholipids, the critical surface pressures of penetration (Пc) were 18.2 □ 0.2 and 11.9 □ 0.1 mN m-1 for NTAIL and lysozyme, respectively. Experiments with the drop tensiometer confirmed a weaker affinity for the interface of both NTAIL and lysozyme when a monolayer of phospholipids was previously formed at the surface of air bubbles using liposomes injected in the water phase. Overall, while lysozyme showed the typical features of a structured protein undergoing structural changes at the interface with an elastic behaviour, NTAIL showed a strong gain of structure upon adsorption with a high elastic modulus. NTAIL adsorption at various interfaces is thus characterized by a gain in protein order, probably resulting from protein aggregation.

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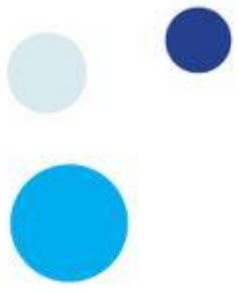
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TALKS

Dynamic properties of DNA/Surfactant Adsorption Layer

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Keywords: DNA/Surfactant Solutions, Surface Rheology, Adsorption Kinetics

Main Topic: Interfacial rheology

Application of cationic surfactants as nonviral vectors resulted in the interest in DNA interactions with Langmuir monolayers of insoluble cationic surfactants. At the same time, only few authors studied the simultaneous adsorption of DNA with soluble surfactants and the corresponding Gibbs monolayers by measuring their equilibrium surface properties. Application of kinetic methods of surface chemistry to DNA/surfactant solutions in this study led to unusual behavior. The dynamic surface properties changed fast for a few minutes after the formation of new interface, remained constant for about half an hour and changed slowly again during a few hours. The simultaneous ellipsometric measurements indicated only smooth monotonic increase of the DNA adsorbed amount [1]. One can explain the obtained results assuming a phase transition of the first order in the adsorption layer. The comparison of experimental data with calculated kinetic dependencies of the surface properties and application of the probe microscopy allowed us to explain the main steps of the adsorption kinetics. The first step corresponds to the fast adsorption of surfactant monomers leading to the formation of the surfactant reach surface phase. The gradual adsorption of the complexes results in the formation of DNA/surfactant fibrils at the interface. When the islands of fibrils start to interact, the dynamic surface elasticity and surface tension continue to change after a plateau region. Note that the heterogeneous adsorption layers have been also observed in the solutions of the complexes between synthetic polyelectrolytes and oppositely charged surfactants, but the surface phase transitions of the first order have never been discovered [2]. This work was supported by Ministry of Science of Taiwan and Russian Foundation for Basic Research (№ 16-53-52034 MHT_a).

Thank you for observation of the above instructions.

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New surfactant mixtures for fine foams with slowed drainage

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We form and investigate foams stabilized by a triple surfactant mixture containing a nonionic alkyl polyglucoside (APG) in addition to the combination of ionic sodium lauryl-dioxyethylene sulphate (SLES) and zwitterionic cocamidopropyl betaine (CAPB) surfactants. APG improves the surfactants compatibility at alkaline pH. The addition of a readily biodegradable chelating agent methylglycinediacetic acid (MGDA) in the mixture contributes further for the excellent performance even in very hard water.

Foam properties are analyzed and compared to those of the single components and to the binary mixture without APG. Foam drainage is successfully controlled by introducing additives suitable for the alkaline conditions: fatty alcohol and/or hydrophobically modified starch.

Systematic model experiments are performed to characterize the surface tension and dilatational rheology, and thin films drainage. Slowed foam and thin films drainage is confirmed to correlate with the increased surface visco-elasticity in the presence of fatty alcohols. Temperature impact on the surface properties is used for fine tuning of the foam drainage.

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Keywords: Corium, CFD modelling, VOF method
Main Topic: Bubble & drop in industrial applications

Nuclear accidents above INES Level 7 could imply severe damage of the reactor containment. One of the consequences is the partial (or total) meltdown of the nuclear fuel due to the loss of the main cooling system. This molten material, called corium, consists of a mixture of the nuclear fuel together with zircaloy (material of the first confinement barrier) and different reactor structural materials such as stainless steel. In case of failure of the vessel, the corium mixture will interact with the concrete containment pit, third barrier before soil and ground water contamination. In this context, the configuration of metallic and oxidic phases, two immiscible liquids, will play an important role in corium-concrete phenomena. Especially, the specific interaction between the metallic phase and the concrete will modify the ablation process.

In order to model and study the interaction of corium with a concrete containment pit, the VULCANO-ICB experiments at CEA - Cadarache are conducted (Journeau, 2009) using prototypical materials (bath based on UO2 and molten steel). This experimental system modelled the coexistence of a dispersed phase (metallic droplets and gas bubbles) in a continuous phase (uranium oxide), capillary phenomena, heat exchange and gravity. A stratification, by which dense liquids are found beneath lighter ones, was expected. However experiments demonstrated separation of the metallic phase in macroscopic proportions. This is demonstrated by post-test analysis that evidence configurations in which the metallic phase is preferably close to the vertical concrete walls of the containment pit. Numerical simulations have to be employed in order to understand such unexpected behaviour of the model system.

Results of two-dimensional CFD simulations of a metal-gas-oxide model system will be presented. The corium has been modelled under isothermal conditions as a dispersed medium with multiple metal drops and gas bubbles. A multiphase volume of fluid (VOF) code is employed (Lekhlifi, 2014; Lekhlifi, 2015). Further studies will include heat transfer and action of thermocapillary and solutocapillary stresses at system's interfaces, as well as reactivity to account for metal oxidation.

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Manipulation of the Electrically Charged Droplet

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Keywords: Electrical Charge Droplet
Main Topic: Bubble & drop formation, motion, interactions

Droplets of oil were electrically charged using a dedicated device based on electro-migration of the charges in the liquid. A charged droplet may easily loose its charge when it touches a solid. In the present case, the droplet was released on a bath of oil that was vertically shaken. In so doing, an air film prevents the droplet from coalescing. The droplet is bouncing and discharges very slowly. That means that they can be manipulated by an additional horizontal electric field.

The law governing the motion of the droplet has been deduced as a function of the size of the droplet and of its charge. We discover that in a precise range of radius and of charge, the droplet is moved with a constant speed. This allows a precise way to manipulate droplet without contact.

The interaction between two electrically charged droplets was also characterised. The droplets were charged with opposite charges. The natural repulsion due to the menisci can be balanced by the electrical interaction.

Finally, the discharge rate was experimentally deduced. The discharge was found to follow an exponential decay and was modelled by a condenser discharge.

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Non-linear surface rheology of spread monolayers of lung phospholipids

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Keywords: Non-linear surface rheology

Main Topic: Interfacial rheology

Coalescence of bubbles in foams and functionality of lung surfactants strongly depend on the dynamic elasticity of adsorption layers. Almost all the investigations of dynamic surface properties focused on small deformations when a response of the system is proportional to the deformation (linear behaviour). However, in practice the relative deformations are not small and the corresponding response proved to be non-linear.

It has been proposed recently that the method of stress decomposition can be used not only for the estimation of limits of a linear approximation, but for the determination of the dynamic surface elasticity from the non-linear response [1]. In this work, we compared the results for spread monolayers of phosphine oxide at large deformations (up to 50%) with the surface elasticity obtained at small deformations with the aim of verification of the applicability of this method. It was shown that the agreement between the results for small and large deformations significantly decreased with the increase of non-linearity. To describe the non-linear behaviour a modified stress decomposition method was proposed. It takes into account the contribution from small deformation into the non-linear response and leads to much better agreement. In this case we used the stress decomposition method to analyse two signals with different relative deformations (for example, 40 and 50%), and subtracted the data for smaller deformations from the data for higher deformations.

The application of the modified stress decomposition method for the investigation of spread monolayers of di-palmitoyl phosphatidylcholine (DPPC) allowed us to determine the dilational surface elasticity in dynamic state at extremely low values of surface tension (up to 1 mN/m). We also investigated mixed monolayers of DPPC with cholesterol and di-myristoyl phosphatidylethanolamine at the same conditions. It was shown that the addition of other components led to an increase of the dynamic surface elasticity and minimal values of the surface tension, which can be achieved under compression of the surface.

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Keywords: bubble terminal velocity; water-alcohol mixture; anomalies
Main Topic: Bubble & drop formation, motion, interactions

The aqueous solutions of simple alcohols, as methanol, ethanol and propanol, are used in many industrial, biological, pharmaceutical and daily processes. We meet with them so often that we do not realize their atypical properties. Relatively well–known is the volume reduction of the mixture in comparison to the volume in the "pure" alcohol or water states. From the chemical-engineering point of view, the maximum in viscosity–composition dependence and lower wettability[1] in comparison to common liquids have a much greater significance. This unusual behaviour is caused by the solution microstructure – simple alcohols are micro heterogeneous since they tend to develop distinct local microstructures consisting both of alcohol and water molecules. The existence of this molecular organization has been proved by several independent methods. The values of the mole fraction corresponding to the aggregation of methanol, ethanol and propanol determined on the basis of the surface tension isotherms[2] are equal to 0.28, 0.17 and 0.07, respectively. The aggregation cause also significant anomalies in the behaviour of systems where the surface phenomena play an important role. The typical example is the motion of bubbles through the carrying bulk liquid. The terminal bubble velocity is influenced by the surface mobility expressed using the drag coefficient. The bubble surface is mobile in pure liquids and immobile in contaminated systems where impurities or surface active agents are present. We found that in solutions with low alcohol concentration, where the aggregation does not occur, and the alcohol molecules behave as surfactants. The bubble surface is partially immobilized and the drag coefficient increases. On the other hand, in solutions above the critical alcohol content the alcohol molecules are tightly bound in aggregates and the bubble surface remains mobile. The bubble motion was captured by the high speed camera and the experimental bubble terminal velocity was compared with existing models reflecting both mobile and immobile bubble surface.
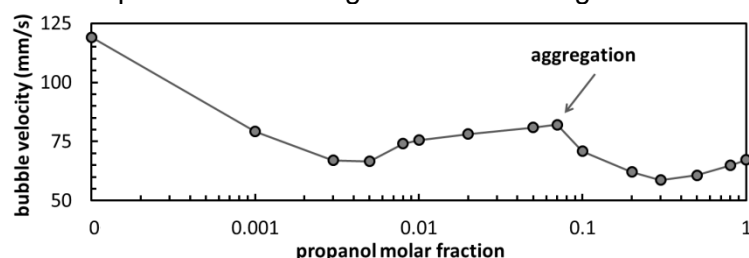

Fig. 1 Terminal bubble velocity in propanol – water mixtures. Data for bubble diameter 0.6 mm.

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Stimulable, Stable and Biocompatible W/O/W Emulsions for Encapsulation and controlled Delivery of Drugs

Noémie, Bodin

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Keywords: Multiple emulsion, stimulable, encapsulation

Main Topic: Foams and emulsions

Water-in-oil-in-water (w/o/w) emulsions are promising systems for encapsulation and controlled delivery of drugs. A new amphiphilic copolymer (PDMS-*b*-PDMAEMA) was developed as an emulsifier for preventing the notorious instability of those emulsions and was capable of stabilizing multiple emulsions for more than a year[1]. This polymer is stimuli responsive, allowing the formation in a single mixing step, of direct, inverse and w/o/w emulsions, depending on the pH and ionic strength of the aqueous phase. Consequently, by changing pH, w/o/w emulsions can be destabilized and a compound encapsulated in the internal water phase is released in a controlled way. The use of microfluidic PDMS chips for a better control of the size and the morphology of the emulsions was also studied.

The aim is to use this promising system to coencapsulate and protect two molecules of interest for health: catechin, an hydrophilic molecule from green tea, and curcumin, an hydrophobic molecule from turmeric. These two antioxidants have lots of potential health benefits[2,3] but are very fragile and difficult
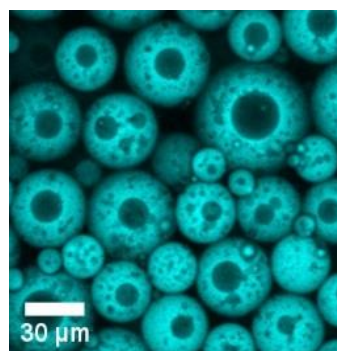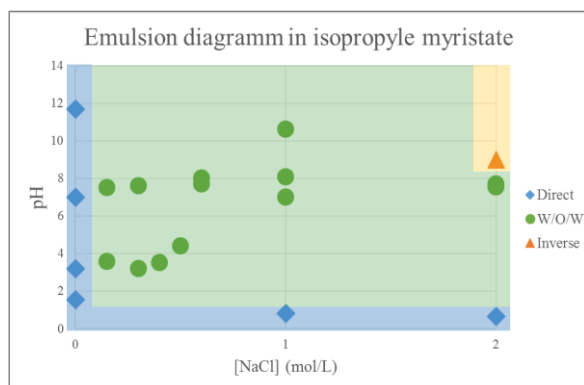
Left: Emulsion diagram showing the type of the emulsion obtained in a single mixing step as function of pH and ionic strenght – Right: Confocal microscopy image of a w/o/w emulsion (oil appears in blue)

to deliver: formulating them in a double emulsion will allow to preserve them during storage and should improve the absorption.

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Ultrasound transmission through model liquid foams

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Keywords: acoustics, liquid foams, microfluidics.

Main Topic: (5) Foams and emulsions

While the acoustic properties of solid foams, which are frequently used for soundproofing purposes, have been abundantly characterized (Attenborough, 1982), sound propagation in *liquid* foams remains poorly understood. J. Pierre and collaborators have recently investigated the transmission of ultrasound through polydisperse liquid foam samples (Pierre, et al., 2013; Pierre, et al., 2015). Their study showed that the mechanical coupling between the liquid network in the foam and the thin liquid films separating the bubbles could result in a large attenuation, associated to a resonant behavior (Pierre, et al., 2014).

The acoustic propagation in a foam strongly depends on its structural parameters (number, surface and thickness of the films, liquid fraction, among others), all of which were not well characterized in previous experiments. Further progress thus requires to investigate the acoustic response of well-controlled foam structures. We introduce a new experimental setup designed to study the transmission of ultrasound (frequencies in the range 70 – 1000 kHz) through model monodisperse liquid foam samples generated by microfluidics. We will present measurements of the acoustic transmission trough monodisperse bubble monolayers of various liquid fractions and bubble sizes. The analysis of these measurements will allow us to retrieve the sound velocity and attenuation in bubble monolayers as functions of their structural parameters.

Additionally, preliminary results on bubble bilayers already show a qualitative difference between the transmission through bubble monolayers and bilayers. This is likely a signature of the free liquid films separating the top and bottom bubbles in the bilayer. This discrete approach, allowing to isolate the signature of a single layer of free films in the acoustic response, will contribute to a better understanding of the dissipation in liquid foams. On the long term, this work could contribute to the design of optimized acoustic metamaterials created by solidification of liquid foams.

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Study of Interfacial Properties To Anticipate Foaming Episodes In WWT

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Keywords: Foaming, interfaces, waste water treatment.

One of the most relevant problems in wastewater treatment industry concerns foam formation episodes that are recurrent, problematic and expensive to solve. The current challenge for these industries is to control the foam formation by a better understanding of these phenomena, in order to manage and adapt their processes. Regardless of the industrial field, the phenomenon of foaming has been the subject of numerous studies over the last 40 years, without any solution proposed to anticipate it [1-2]. However, it is well known that foaming is a complex phenomenon related to the presence of amphiphilic agents (surfactants, proteins, bacteria, extracellular polymeric substances…) or hydrophobic particles. These molecules have the ability to adsorb to the liquid/air interfaces, facilitate and stabilise gas bubbles coming from the aeration process into the treatment tanks. This work aims to anticipate foaming phenomena by developing correlations between foam ability and measurable physicochemical properties of waste water. This works takes place in the framework of the MOCOPEE program (MOdelisation, Control and Optimization of Water Treatment Processes) which is devoted to the development of a knowledge-based optimization of water treatment processes.

The scientific approach planned consists of studying the interfacial properties (equilibrium and dynamic surface tension respectively measured by Wilhelmy Plate and Bubble Maximal Pressure methods), characteristic of the amphiphilic agent adsorption capacity, and the foaming properties (foam ability and foam stability using modified Bikerman method [3]). Studies are performed on samples taken on the wastewater treatment plant and systematically compared with model aqueous solutions prepared for a mixture of amphiphilic molecules, in order to identify the role of each material on the foaming. The first results show that the most effective foaming effluent is characterized by a high foam ability, equivalent to small surfactants' model solutions as CTAB (cetyltrimethylammonium bromide) or SDS (sodium dodecylsulfate), but a very weak foam stability, similar to a protein model solution of BSA (bovine serum albumin), at their optimum foaming concentration (from CMC to 10CMC). The dilatational viscoelasticity of the systems will be explored with a drop-profile tensiometer based on the oscillating bubble method at low perturbations [3-4] for more information.

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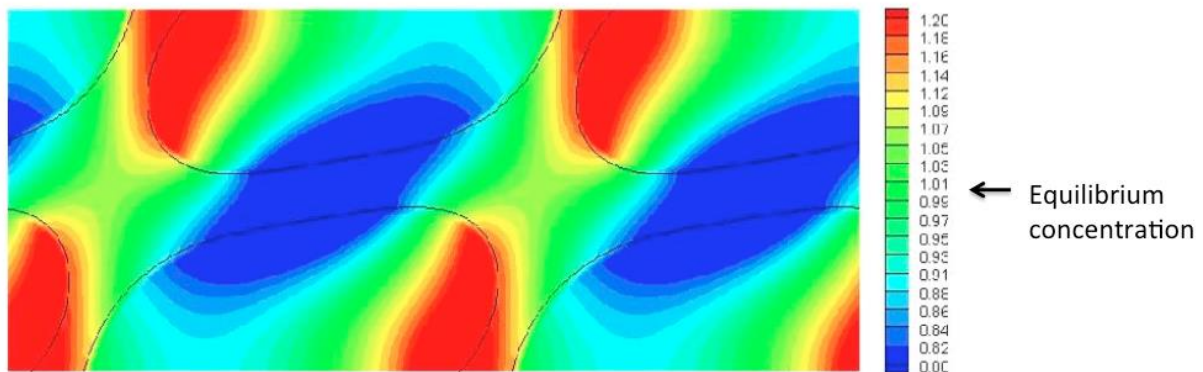# Simulations of Sheared Bubbles with surfactants-laden interfaces

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Keywords: bubble rearrangements, surfactant dynamics, simulations

We investigate the dynamics of sheared wet foams with numerical simulations based on the levet-set method (Ó Náraigh, 2014), where we fully account for the adsorption/desorption and diffusion dynamics of surfactants and how the associated modified stress conditions at interfaces impacts the hydrodynamics of the liquid films inside the foam. We shall report on the role of surfactants and their properties on T1 events, wherein adjacent bubbles are sheared past each other. In particular, we will discuss the effect of Péclet number, which compares advection and diffusion dynamics, on both interfacial dissipation and flow features. We also present simulation results on the role of surface viscosity.
* Support from grant ARC Energie, by Rhône-Alpes region, is gratefully acknowledged.

Figure: simulation of sheared bubbles. The color represents the bulk surfactant concentration (numerically defined in the whole domain, but meaningful only in the liquid).

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FT-IR imaging spectroscopy investigations of spontaneous emulsification kinetics

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Keywords: Spontaneous emulsification, Span 80, FT-IR imaging spectroscopy
Main Topic: Foams and emulsions

Spontaneous emulsification is an intriguing phenomenon whose understanding is of much scientific interest [1]. Substantial research work has been reported on it but the mechanisms of this process are not yet fully understood. Current applications in drug-delivery systems and petroleum industry require deeper understanding of spontaneous emulsification.

In the present work, FT-IR imaging spectroscopy with a Focal Plane Array (FPA) detector has been used. This analytical technique has the advantage to allow the identification of chemical compounds in the complete field of view (FOV). But, it requires the use of IR transparent solvents for larger optical path length.

We observed the spontaneous emulsification at water/CCl_4 interfaces in the presence of a lipophilic surfactant Span 80. When the concentration of Span 80 in CCl_4 is large, reverse micelles are known to be formed in such low dielectric solvents. Reverse micelles at the interface tend to swell over time before detaching from the interface [2]. They are then transported into the organic phase and contribute to the increasing opaqueness.

FTIR imaging spectroscopy analysis shows the appearance and evolution of the depth of O-H stretching band (3200-3500 cm^{-1}) over time in the CCl_4 phase. This is the signature of the transport of water. Experiments were performed for different surfactant concentrations to study the kinetics of this process. It was observed that the amount of surfactant clearly influences the turbidity of the Span 80/CCl_4 solution. Figure 1 illustrates that the kinetics of the water transport process becomes faster for higher concentrations of Span 80.
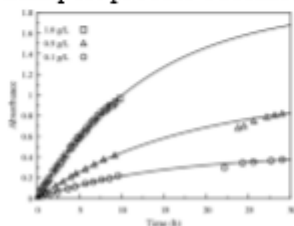

Figure 1: Evolution of the average absorbance (over the full FOV) of the Span 80/CCl_4 solution as a function of time for Span 80 concentrations of 1 g/L, 0.5 g/L and 0.1 g/L.

DLS experiments have been performed. They confirm that the micelles swell with time and reach typical sizes that further depend upon the Span 80 concentrations.

This work shows that FT-IR imaging spectroscopy is an adapted tool for characterizing spontaneous emulsification processes. It allows the investigation of the time evolution of the concentration gradients. This should help in the future to estimate the diffusion coefficient of micelles.

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Dimple formation in asymmetric pseudo emulsion films

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key words: asymmetric film (gas-water-oil), film stability, dimple formation

The stability of foams in contact with an oil phase is important for the application of foams in many technical processes. It ranges from the reduction of foam production (defoaming) in case of transport of liquids to formation of stable foams in the case of enhanced oil recovery. In these cases very often asymmetric oil/water/gas pseudo emulsion films are formed. The stability of these thin liquid films is thermodynamically well understood and described in the literature [1-3]. The stability of the foam and the stability of a single foam film in contact with oil depend on the spreading or entering of the oil phase. Additionally, interfacial interactions in the film need to be considered which led to the definition of the generalized entering coefficient [4, 5]. However, less attention was paid on how the hydrodynamics of film formation affect foam and foam film stability. The present study focused on the description of the velocity of film formation and formation of dimples in asymmetric foam films and its relation to the film stability.

For this purpose, a new experimental set-up was assembled with which the formation of asymmetric pseudo emulsion films can be studied reproducibly. The set-up is based on the traditional glass ring cell used for studies with symmetric foam films. The film thickness is measured using the microinterferometric technique. The set-up allows measuring the thickness, the thinning velocity and the stability of the thin liquid films in contact with an oil droplet. As way of example we measured the stability of asymmetric films stabilized with two anionic surfactants at different ionic strength. Different oils were used as oil phase including well defined model oils but also some crude oils. The results show that stable asymmetric foam films are formed at high surfactant concentration and that the film stability increases with increasing electrolyte concentration. It is observed that at high electrolyte concentrations dimples which are stable for many minutes are formed in the films, which assures high film stability. The formation of the dimples is studied and the parameters responsible for dimple formation are analyzed. The behavior of the asymmetric foam films is compared to that of symmetric gas/water/gas foam films. The results of the study are important for optimization of technical processes where formation of asymmetric oil/water/gas films is expected.

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Particle foam flotation of nano–clay particles with bi-functional surfactant

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Keywords: Foam, particle flotation, clay particles

The Accident on the Fukushima Dai-ichi power plant on 11th of March 2011 has released unprecedented amounts of radionuclides into the atmosphere leading to soil contamination. Caesium-137 with its long half-life of 30.07 years causes the largest concern because it adsorbs onto clay particles (especially illite and montmorillonite) making agricultural soil unusable. In this context particle foam flotation of clays is considered for soil remediation.[1]

This method consists of first prepare an aqueous dispersion of clay charged with caesium. Then by adding a foaming agent and bubbling gas in the solution, foam can be created. This allows extracting and concentrating the clay particle within the foam structure through adsorption at the liquid-gas interface.

In the present contribution, particle foam flotation of synthetic (Laponite RD) and natural (Na-rich montmorillonite Swy-3) smectite clay nanoparticles is investigated using a pH sensitive bi-functional surfactant named Ethomeen C/25 (ethoxylated tertiary amine). The clays are negatively charged particles whereas the surfactant has an ionisable amine function which can interact with the particles when it is under its cationic protonated form. Surface tension measurements and foam analysis (Small Angle Neutron Scattering, and image and conductometric analysis, e.g. Foamscan) on Ethomeen C/25 solution allow relating aggregation and ionic properties to foaming capacity.

Furthermore, the surfactant demonstrates a high efficiency to extract clay particles in acidic condition via particle flotation and the capacity of the foam to concentrate clays in PLATEAU borders leading to sol-gel transition within the foam. In addition the use of a pH sensitive surfactant provides the opportunity to separate surfactant/particle entities by tuning pH.[2] The results are discussed in terms of Cs^+ distribution coefficient, nano-particles recovery and surfactant surface activity.

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Bubbles motion and capture in water–saturated sands

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The dynamics of gas rising through mobile grains immersed in a liquid has many applications in the geophysical or industrial context [Biardi & Baldi, 1999; Hovland et al., 2002]. This work investigates the dynamics of bubbles in a confined, immersed granular layer submitted to an ascending gas flow. In the stationary regime, a central fluidized zone of parabolic shape is reported [Varas et al., 2011; Ramos et al., 2015; Varas et al., 2015]. The bubbles follow different dynamics: either the bubbles are initially formed outside the fluidized zone, and do not exhibit any significant motion over the experimental time; or they are located inside the fluidized bed, where they are entrained downwards and are finally captured by the central air channel.

The dependence of the air volume trapped inside the fluidized zone, the bubble size and the three-phase contact area on the gas injection flow-rate and grains diameter are quantified. We find that the volume fraction of air trapped inside the fluidized region is roughly constant and of the order of 3-4% when varying the gas flow-rate and the grains size. Contrary to the intuition, the gas-liquid-solid contact area, normalized by the air injected in the system, decreases when increasing the flow-rate, which may have significant importance in industrial applications [Poryles et al., 2016].

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Keywords: bubbles, complex fluids, instabilities

Bubbles rising in non-Newtonian fluids exhibit a wide range of puzzling behaviors: singularity at the bubble rear (cusp) [Chhabbra, 1993; Leal et al., 1971], negative wake [Hassager, 1979], oscillations of the bubble shape or velocity [Belmonte, 2000; Handzy & Belmonte, 2004], etc. In this experimental study, we investigate the effect of confinement on a single air bubble rising in a polymer solution. The setup consists of a vertical quasi two-dimensional system (Hele-Shaw cell), filled with a concentrated polymer solution of polyethylene oxide (PEO) in water. This fluid displays elastic properties as well as a shear-thinning behavior. Single bubbles are then injected at the bottom of the cell, and we study their morphology and dynamics depending on their volume and on the polymer concentration.

When increasing the bubble volume, a transition is observed from a small, round bubble to a cusped bubble, which exhibits a singularity at the rear. Below a critical volume, the bubble rises vertically and does not exhibit any apparent shape deformation. However, above a critical volume, the cusped bubble develops a peculiar instability. Its front flattens at a given angle respect to the horizontal, leading to either a deflection in its trajectory, or its fragmentation. We characterize these two dynamics and interpret the fragmentation process in terms of a viscous fingering recalling the Saffman-Taylor instability. Interestingly, the finger growth is directly controlled by the bubble size [Poryles & Vidal, 2017].

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Turning metal-coated materials into superhydrophobic surfaces

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Keywords: Metal-coated materials, superhydrophobic surfaces, sandblasting,

A great number of metal materials used in industry are composed by metal coatings which are used to provide additional properties to the inner material. Within these type of materials, two of the most used ones are galvanized steel (GS) or aluminized steel (AS). In GS, the chosen coating is zinc. It is used for its hardness and its low melting point. GS is widely employed in industry: roofing, edification, fabrication of urban material or ski resorts. AS uses a Si-Al alloy as coating and it is used in cookware industry mainly for its compatibility with food contact.

The incorporation of superhydrophobic (SH) properties to these materials would add other properties of extreme importance and applicability: On GS, the reduction of staining and corrosion, biofouling prevention and anti-icing properties, among others, would be of extreme importance. On AS, the SH properties would incorporate non-stick properties.

However, these materials are scarcely chosen to fabricate SH properties, mainly because the strategies used to generate durable SH surfaces on metals are aggressive and damage the surface material. Any finishing that may destroy the coating or may reduce its functionality is not desired.

In this work, we show several non-aggressive routes to produce SH surfaces on AS and GS[1]. The fabrication is based on two independent routes: a previous texturing process aimed to produce roughness on the surface, followed by a hydrophobization process using low-energy materials. Both features (high roughness and low surface energy) are necessary conditions to create SH surfaces. The texturization was based on the application of two different surface treatments; sandblasting and soft acid etching. The combination of both treatments were able to create roughness at micro and nano-scale, respectively. The hydrophobization was carried out using fluropolymer deposition and surface silanization. We demonstrated that our treatments were efficient in creating durable water-repellent surfaces and the damage produced on the zinc and Al-Si coatings (coating removal) was negligible. Contact angle and roughness measurements, thickness loss estimation, elemental chemical analysis and durability tests were used for these purposes.

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Flow Regime Identification with Fast Electrical Impedance Tomography

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Keywords: Electrical Impedance Tomography, Phase Fraction, Flow Regime Identification

A prototype electrical impedance tomography (EIT) sensor was developed during the last two years at CEA Cadarache in the framework of the main author's PhD thesis. Recent developments with data acquisition equipment have reduced the time required for image acquisition, thereby bringing new opportunities for the study of fast-evolving two-phase flows. Amongst the numerous advantages of this imaging technique are non-invasiveness, low cost and fast acquisition rates. A set of electrodes placed on the periphery of the pipe to be imaged is used to impose an electrical stimulation and measure the system response. The distribution of phases inside the probed volume distorts the electrical field in a characteristic manner.

The system was designed for a maximum acquisition rate of 800 frames per seconds considering the full scan strategy. This major breakthrough gives new opportunities for the imaging of fast evolving multiphase flows. The performance assessment study will be discussed in the paper. The image reconstruction algorithm implemented for the resolution of the tomographic inverse problem will be explained. Recently, the sensor was inserted in a two-phase flow facility at the top of a vertical pipe. The study of developed vertical upward flows will be presented and the image sequences will be compared with high-speed video recordings and predictions from flow regime maps.

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Sulfonated methyl esters, linear alkylbenzene sulfonates and their mixed solutions: micellization and effect of Ca2+ ions

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The interest to sulfonated methyl esters of fatty acids (SME) has been growing during the last decade, because these surfactants are considered as an environmentally friendly and renewable alternative of the linear alkyl-benzene sulfonates (LAS). Here, we compare the properties of sulfonated methyl esters of fatty acids (SME) and linear alkylbenzene sulfonate (LAS) with respect to the effect of calcium ions on their surface tension and the effect of their mixing on the critical micelle concentration (CMC). The theoretical interpretation of surface tension isotherms obtained in the presence of NaCl and $CaCl_2$ allowed us to determine the parameters that characterize the surfactant adsorption layers and counterion binding. The excluded area per molecule in the adsorption layer is the same for SME and LAS, and is determined by the cross-sectional area of the sulfonate headgroup. The binding energy of Na^+ ions to the headgroups of SME and LAS is also the same (1). However, the binding energy of the Ca^{2+} ion to the headgroup of LAS is considerably greater than that of SME in agreement with the circumstance that LAS is precipitated by hard water. In contrast, the binding energy of the Ca^{2+} ion to the headgroup of SME is smaller even than that of Na^+, in accord with the reputation of SME as one of the most hardness tolerant surfactants. The dependences of the CMC on the composition of binary mixed surfactant solutions reveal that C14-SME and C16-SME exhibit ideal mixing; C14-SME and LAS – slightly synergistic mixing, whereas C16-SME and LAS – antagonistic mixing due to hydrocarbon-chain mismatch.

The micellization in mixed solutions of SME and cocamidopropyl betaine has been also investigated. The results in the present study allow prediction of the surface tension of solutions of SME and LAS in the presence of Na^+ and Ca^{2+} ions at various concentrations; contribute for a better understanding of the different tolerance of SME and LAS to hard water, and quantify the effect of their mixing on the CMC (2).

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Keywords: self-assembly, H-bonding, tectomer

Aqueous systems based on synthetic antennary oligoglycines have high potential for biomedical and water-purity-control applications. The oligoglycine molecules self-organize into supramolecular assemblies (tectomers) in aqueous media, forming bulk hydrophilic nano-platforms, vesicles, etc. [1]. The innate reason for the self-organization is the onset of highly cooperative arrangements of intra- and intermolecular hydrogen bonds. The properties of these smart complex fluids can be finely tuned by changes of pH and/or the addition of charged entities (low-molecular-mass electrolytes or high-molecular-mass substances). A combined procedure is developed based on PAT technique, microinterferometric thin-liquid film instrumentation and DLS studies. The experimental approach allows extracting valuable information about the inception and stability of bulk aggregates of various sizes and charges, examination of the properties of the interfacial layers at the solution/air boundary and the drainage characteristics of microscopic foam films. Due to the specific structure of the obtained tectomers, these aqueous system formulations may be applied for the entrapment of charged nano-species of various origins.

The obtained results suggest that the self-assembled nanostructures of antennary oligoglycines may be implemented e.g. as indicators and captive agents for trace quantities of dangerous substances of biological origin (endotoxins) in aqueous media [2,3].

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The Relationship between Structure and Foaming Performance for a Range of Different Types of Chemical Surfactant

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Keywords: Foaming, surfactant structures

In many industrial processes (such as foods, cosmetics, flotation, paints, lubricants, detergency, fire-fighting, beers, etc.) surfactant are added or may be present in the original formulation which can cause foaming. In many of these processes, both the initial foam volume generated and the stability of the foam (foam height) after a well-defined period of time are considered to be important parameters and these are frequently quantified by the chemical surfactant manufacturers. These parameters clearly depend on the type, structure and concentration of surfactant in the system and can be measured using the Ross Miles foam test equipment. In this paper we present data from a wide range of surfactant systems and the foaming performance is presented by a simple plot of foamability versus foam stability. This enables five distinct performance regions to be defined as shown below. Finally, the physical chemical mechanisms which define both the foamability and foam stability such as the packing parameter, interfacial elasticity, gas diffusion, drainage are discussed to explain the data. In addition the influence of such parameters such as the nature of the foaming vessel on performance was determined. This paper will be useful for important for industrialists from many different types of foaming processes.

(a) The Ross-Miles test apparatus enabling foaming to be classified by foamability (foam generation) and foam stability. (b) The classification of foaming systems into five regions
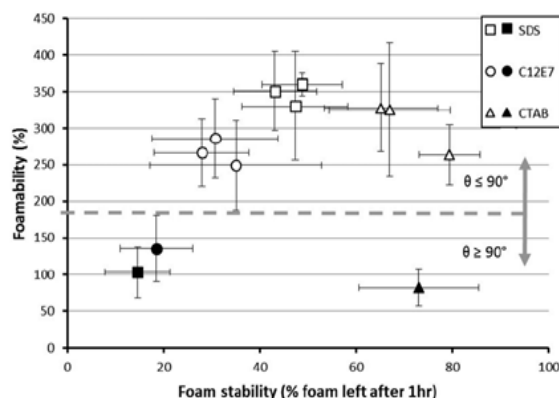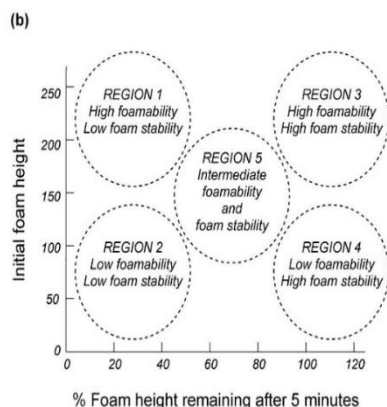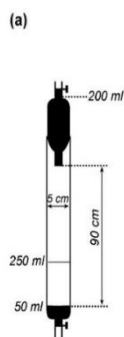
depending on the foamability and foam stability as determined by the Ross Miles test apparatus.

Foams with fast and slow Ostwald ripening

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The foam formation and decay with focus on Ostwald ripening of two different surfactant mixtures are studied. One mixture contains ionic sodium lauryl-dioxyethylene sulphate (SLES) and zwitterionic cocamidopropyl betaine (CAPB) surfactants, the other one additionally contains nonionic alkyl polyglucoside (APG). The foam, liquid and total volume as well as liquid content, global liquid fraction and foam structure are investigated at two different temperatures. The total volume after foaming of all samples is comparable at neutral and alkaline pH. Higher temperatures lead to an increased total volume and hence higher foamability. Furthermore, the liquid fractions of the foams are reduced and the Ostwald ripening is stronger at higher temperatures. This results in a faster destabilization and decay of the foams. The addition of fatty alcohol (FOH) leads to an improved stability of the foams even at alkaline pH and at higher temperatures (see figure 1). The FOH decreases the drainage and enhances the liquid fraction. The foams consist of stable, small bubbles and show strongly reduced Ostwald ripening.
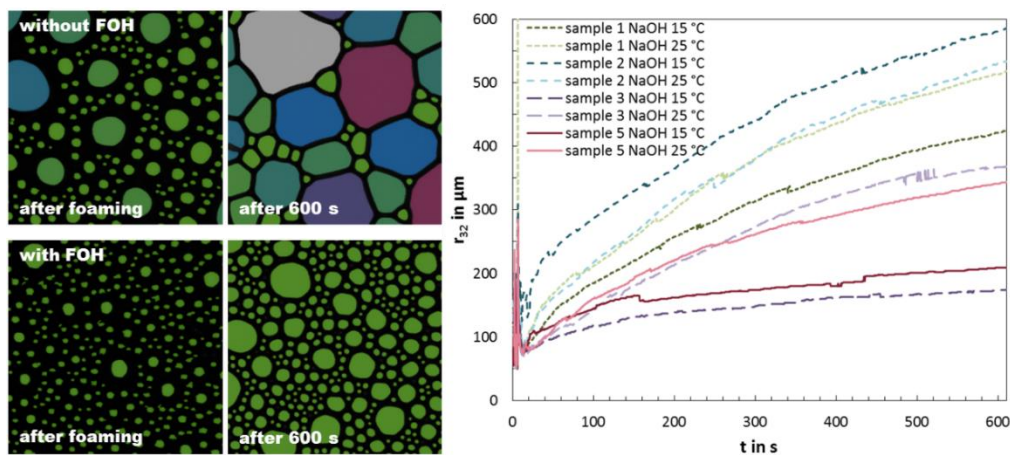
Figure 1: Bubble size distribution of samples without and with FOH directly after foaming (left) and after 600 s (middle), as well as the Sauter mean radius (right). Fast Ostwald ripening is observed in sample 1 (SLES, CAPB, APG), and sample 2 (SLES, CAPB). For samples 3 (SLES, CAPB, APG + FOH) and 5 (SLES, CAPB + FOH), the Ostwald ripening is strongly reduced.

Growth and Stability of bubbles in an oversaturated liquid

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Keywords : Oversaturation, Growth, Stability

Main Topic : Bubble & drop in industrial applications

Abstract –

Controlling the growth and the stability of bubbles in oversaturated liquids is of interest for the industry of carbonated beverages (soda, sparkling water, beer, champagne…) for several reasons. For example, the bubbles size impacts the size of the emitted aerosols upon bursting, which has been shown to strongly impact the drinker's sensation. Strongly stable bubbles can also lead to the formation of foam, which can be appreciated, to a certain extent (beer), or not (Champagne). In turn, understanding the mechanisms underlying these processes can be of interest to assess different problems such as foams stability or even climatology since aerosols emissions above the ocean depend on the thickness of the bubble cap, itself driven by the bubble lifetime before bursting.

In this work, we have set two model experiments in order to study the impact of sucrose on the formation and coalescence of bubbles in carbonated beverages. Carbonated beverages are liquids oversaturated with carbon dioxide.

In the first experiment, we monitor a single bubble growing in a controlled physicochemical environment. We measure the growth rate as well as the surface tension as a function of the oversaturation.

The second aspect of this study concerns the stability of a bubble once it has reached the liquid/gas interface under the influence of its increasing buoyancy. In this second experiment, we measure the lifetime of thousands of bubbles created one after another at the surface of a saturated liquid in a humidity controlled environment.

In both case, aqueous solutions of varying sucrose concentrations are used. The poster features the experimental setups as well as preliminary results obtained from the sucrose solutions.

Simulation and observation of line-slip structures in columnar structures of soft spheres

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Columnar structures arise in their most elementary form when we seek the densest packing of hard spheres in a circular cylinder. A wide range of structures have been identified and tabulated [1], depending on the ratio of cylinder diameter D to sphere diameter d. For each of a set of discrete values of D/d, a uniform structure is found. Between these values, the structure is best accommodated by the introduction of a *line-slip*, which shears two adjacent spirals with a loss of contacts, as shown in Fig (1). Stable structures are found by minimizing the enthalpy for a system of N soft spheres in the unit cell. A part of the resulting phase diagram is shown in Fig (2), where for a given value of the diameter ratio D/d and pressure p the enthalpy is minimized by varying the sphere centres, as well as the twist angle and the volume of the simulations cell. We present the computed phase diagram of columnar structures of soft spheres under pressure [2]. This work based on computation is supported by experiments; a column of bubbles under forced drainage, exhibiting the expected line-slip.
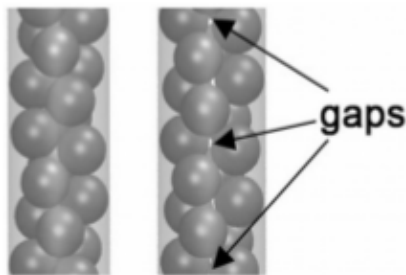
Fig (1): Uniform structure (no gap) and line-slip structure (gap)
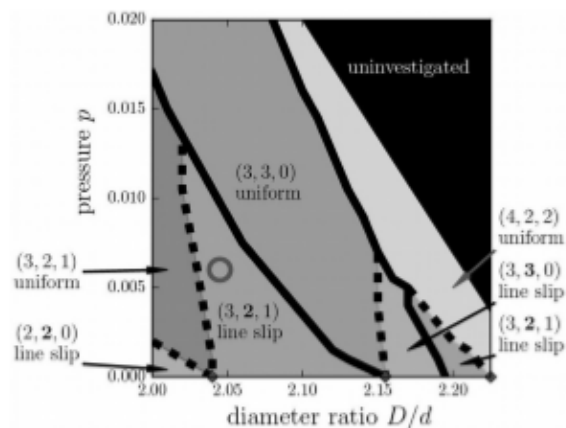
Fig (2): Phase diagram P, D/d

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Mixtures of gas bubbles and oil droplets are ubiquitous in our daily lives. They are found in food products, cosmetics, oil recovery, and even in the precursors for the preparation of solid foams. A photograph of a foamed emulsion is shown in Figure 1. Oil droplets can collect at the surfaces of air bubbles and between the bubbles to stabilize them [1-3] or they can enter into the gas-water interfaces and destroy the foams [4]. Their industrial relevance makes it important to understand the mechanism behind their stability.
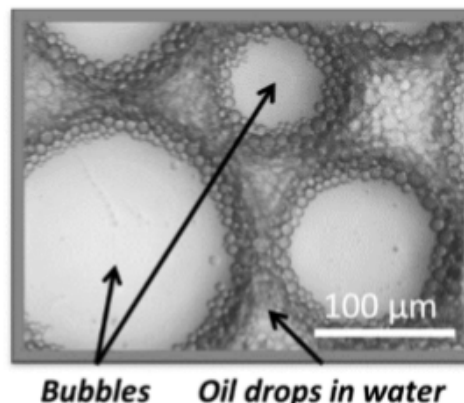
Figure 1: Air bubbles surrounded by rapeseed oil emulsion droplets.

We have studied the ageing of foamed emulsions by combining electrical conductivity and image analysis. This has allowed us to measure the volume fraction of the three fluids inside the foam in time and at different positions in the foam. Although the foam lifetime and evolution depend intricately on the emulsion volume fraction, surfactant concentration and emulsion drop size. We can distinguish three stages of emulsion ageing inside a foam: initial stabilization and flow, blocking if sufficiently concentrated and finally destruction as the drops act as antifoam.

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Ultrastable and stimulable foam from surfactant crystals

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Keywords: foam, surfactant, crystal

Main Topic: Foams and Emulsions

Foams are interesting materials, however for some applications their lifetime is too short. This is why different types of particle-stabilised foams are increasingly studied. We have recently shown that precipitating sodium dodecyl sulphate with sodium or potassium chloride makes crystalline particles that can be very efficient foam stabilisers (1). These foams can be *ultrastable*, as the foam ageing mechanisms are arrested. However, if heated above the Krafft boundary, the crystals melt and the foam continues to age again, making them *thermostimulable*.

We have explored the criteria for the extreme stability of these foams. We show that depending on the concentrations of surfactant and salt, the behaviour of the foams can be classed into one of three types: classically ageing foams; foams with arrested drainage; and ultrastable foams with arrested drainage and coarsening.

The stability of the foams is linked to the concentration of non-precipitated surfactant. If this concentration is too high some of the surfaces are covered by monomeric surfactant and not crystals, as seen in the photograph on the right. Such bubbles continue to coarsen and will eventually disappear.
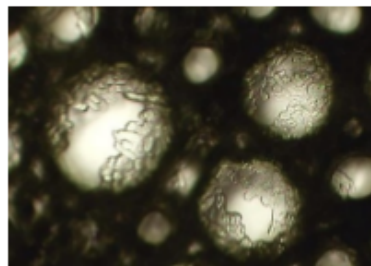
The system offers an interesting alternative to other types of foam-stabilising particles because the surfactant crystals break and reform as the temperature is cycled, which makes for *reusable* solutions and stimulable foams.

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Mussing over a glass of wine, it is almost impossible not to be captivated by the regular pattern of liquid beads that fall along the inside of the glass that is commonly referred as 'tears of wine'. The fascinating feature of this phenomenon is that the tearing takes place while the liquid within the glass is stationary, which is possible only if there is a flow against gravity in the liquid film on the inside of the glass. In 1855, J. Thomson[1] identified the driving force for the upwards flow necessary for the continuous formation of tears as a gradient in interfacial tension. There has been considerable interest in understanding both the Marangoni[2] flow within the liquid film and the instability leading to the formation of tears. However, it is generally accepted that the composition gradient resulting from the evaporation of ethanol is the only contributor to the interfacial tension gradient that leads to wine tears. In this work, we present a transport model with a simple analytic solution that allows us to study the importance of the previously neglected thermal effects[3]. Our model is tested using a novel method to capture infrared thermographs from which the temperature gradient on the surface of the wine film can be extracted. Our results demonstrate that, evaporative cooling contributes significantly to the flow responsible for wine tears. The relative contribution of the composition and temperature gradients to the Marangoni force required to develop wine tears depends on the bulk ethanol concentration and is explained by the thermodynamic behaviour of ethanol-water mixtures. Additionally, the regular pattern of tear formation is identified as a well-known Rayleigh-Plateau instability[4] based on the interplay between inertial and interfacial tension forces that result from disturbances to the surface of the liquid.

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Keywords: droplet lens; Marangoni convection, solutocapillary effect

Liquid-based lenses become important optical elements in optical instruments, photonic devices and microfluidic chips. A liquid droplet as a lens enables the effectively tune of focal length by changing a surface curvature through external forces. Electrowetting, electrochemical, dielectrophoretic and many other forces are used to change a contact angle of liquid on substrate to obtain the required droplet-lens shape and curvature. We demonstrate a novel concept of the droplet-based lens, which can tune not only optical properties in response to a light intensity, but also trace a position of a light beam.

The actuation principle is based on solutocapillary forces generated by a thermal action of the light beam (Ivanova et al, 2015; Bezuglyi and Ivanova, 2007). To obtain solutocapillarity based droplet mixtures of ethylene glycol and ethyl alcohol at various concentrations dyed with crystal violet for absorption of the laser radiation (wavelength 532 nm) were used. A portion of mixture was placed in a sealed optically transparent cell to prevent leakage of volatile liquid. The focal length was measured using images of a grid cell placed beneath the droplet. Over the range of supplied power from 2 to 30 mW the maximum range of the focal-length variation (from 41 to 15 mm) was reached in the mixture of 66%w/w as shown in Fig.1. An ability of the droplet-lens to a lateral motion was also demonstrated by shifting the laser beam parallel to the bottom of the cell (Fig. 2). The driving mechanism behind the movement of droplet is due to the action of solutocapillary forces as described in our previous work (Ivanova et al, 2015).
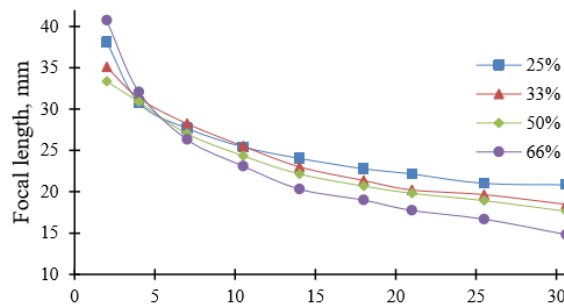

Figure 1: Variation of the focal length vs. the laser power for mixtures at various concentrations
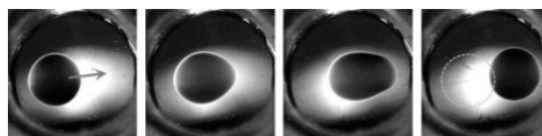

Figure 2: Lateral adjustment of the droplet-lens

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Bezuglyi B A, Ivanova N A, Creation, transportation, and coalescence of liquid drops by means of a light beam, Fluid Dynamics, 41(2), 278-285 **2007**.

# Breathing surfactant droplets caused by the cyclically changed humidity of air

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Keywords: surfactant, spreading, Marangoni forces
Main topic: wetting and spreading

Improving of surface wetting properties is of importance in agrochemical, printing, medical industries. Many researchers considered the air humidity as a key parameter for enhancing spreading of aqueous surfactant solutions and pure surfactants on hydrophobic surfaces (Venzmer, 2011; Ivanova, 2017).
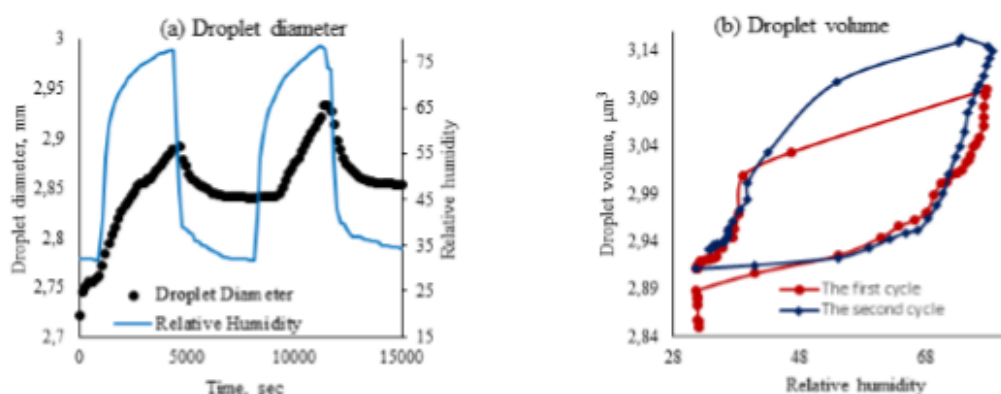
Figure 1: Five-staged spreading process of Silwet L-77 over PTFE substrate: (a) – diameter and humidity vs time, (b) – volume vs. humidity.

We show that the cyclically changing humidity of surrounding air leads to «breathing» of the droplet: both the diameter and the volume increase and decrease with the current humidity level, (Fig. 1). We found the droplet diameter variation occurs with the hysteresis (Fig. 1a), but the volume hysteresis is not pronounced and lays within the errors of experiment (Fig. 1b). These findings suggesting that Marangoni forces caused by the water precursor film drive the spreading of the droplet. This film is formed by condensation of water onto substrate at the droplet edge. Since the droplet volume increases with the rising humidity, water condenses into the droplet surface as well. The shrinkage stages can be explained by evaporation of water that reflects upon the decreasing the droplet volume down to the initial value. Moreover, it is well known that evaporation occurs more intensively from the droplet edge and hence it could lead to the oppositely directed Marangoni forces promoting the droplet shrinkage.

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Dewetting from a Liquid Film into a Single Droplet

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8 Wetting and spreading

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The dynamic spreading of an out of equilibrium droplet into a liquid film on a wetting surface is well studied. However, the reverse model case of a static liquid film evolving into a single macroscopic equilibrium droplet shape is difficult to realise experimentally. Recent progress in developing interface-localized liquid dielectrophoresis has led to the ability to induce and control equilibrium liquid film shapes using a voltage, also called dielectrowetting [1], on otherwise non-wetting substrates. In the extreme case it has been possible to study the dynamics of surfactant-free superspreading from a droplet into a film [2]. Here we show that interface-localized liquid dielectrophoresis can also be used to create an initial static circular shaped liquid film on a non-wetting surface. On-demand quenching of the non-uniform electric field permits quantitative study of subsequent dewetting into a single macroscopic droplet [3]. We observe two distinct regimes in the dynamic dewetting, firstly retreat of a liquid rim (with an associated dimple in the centre of the evolving droplet) at a constant contact angle and contact line speed, followed at longer times by a second regime corresponding to the formation of a spherical cap droplet with an exponential approach to equilibrium. This process sharply contrasts with the process of wetting from a small macroscopic droplet into a liquid film, which proceeds by a sequence of spherical cap droplet shapes. We develop a hydrodynamic theory (following ref [4]) to describe the initial dewetting dynamics and material parameter dependencies of the rim and associated dimple, and the long time exponential approach to the equilibrium spherical cap droplet shape. The theory and our Lattice-Boltzmann simulations reveal a local dewetting mechanism driven by the equilibrium contact angle, where contact-line slip dominates the dewetting dynamics. Our results are relevant to a wide variety of dewetting situations, such as drop rebound, condensation and evaporation. Our experimental approach can be extended to consider the dewetting process for a liquid film displacing a second immiscible liquid phase, and to study the dewetting of films of prescribed initial shapes.

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Reinhard, Miller

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Equilibrium and dynamic surface tensions determined by the analysis of drop profiles and corresponding bubble profiles can deviate from each other significantly (See Fig. 1). In a recent work this difference was used to determine the adsorbed amount of proteins at the solution surface [1].

From a certain surfactant solution concentrations on, a respective loss in the bulk of a single drop happens due to the adsorption of the surface-active molecules at the drop surface. This depletion leads to a final concentration in the drop which can be remarkably lower than the initial concentration was. Thus, ignoring depletion effects would lead to equilibrium data that do not reflect the correct adsorption model. A surface tension isotherm, constructed in this way, i.e. using data from drop profile analysis tensiometry without considering and correcting any possible depletion effects, would lead to incorrect adsorption parameters and hence to wrong adsorption models.

We developed an algorithm for the estimation of the parameters of the equation of state and adsorption isotherm based on experimental data obtained using the drop profile analysis tensiometry. The algorithm assumes the balance between the surfactant mass in the drop bulk and the amount adsorbed at the drop surface, taking into account the surface area and volume of the drop. The obtained results are verified by comparing them with surface tensions measured with the bubble profile analysis as for this methodology any depletion effects are negligible for the given bulk concentrations.
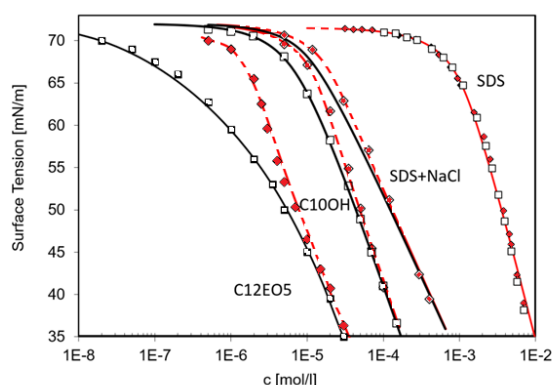

Fig. 1. Surface tension isotherms of surfactants with different surface activities: open symbols – bubble profile measurements, filled symbols – drop profile measurements; red dashed curves – drop-based model fitting; black solid curves – bubble-based model fitting; red solid curve – bubble- and drop-based fitting almost coincident for low-activity surfactant [2]

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Drop-to-bubble transition under acoustic levitation: a tornado in sound field

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In this talk, we will present the dynamics of acoustically levitated drops including their oscillation dynamics and coalescence behaviours (Fig.1). We will put emphasis on the drop-to-bubble transition (Fig.2) triggered by acoustic levitation and the stability of the levitated bubble. During the transition, a levitated droplet evolves from an oblate spheroidal shape to a flattened, thin bowl-shaped membrane, eventually forming a closed bubble. Through systematic experimentation and theoretical analysis, we demonstrated that the buckled geometry of the liquid membrane can drastically enhance the suction effect at the membrane rim, forming a significant pressure gradient inside the membrane which causes an abrupt area expansion and bubble formation. The insights presented here shed light on the acoustic manipulation and curving of other fluid/fluid interfaces, providing a reference for fabricating unique fluidics such as anti-bubbles and core-shell droplets.
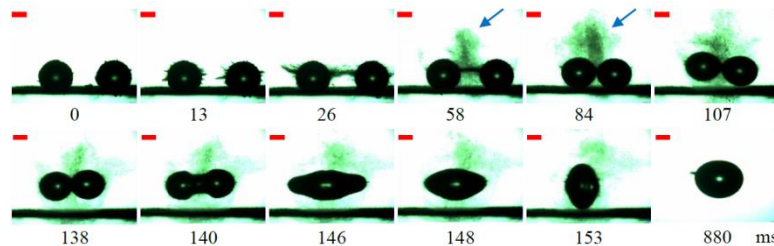

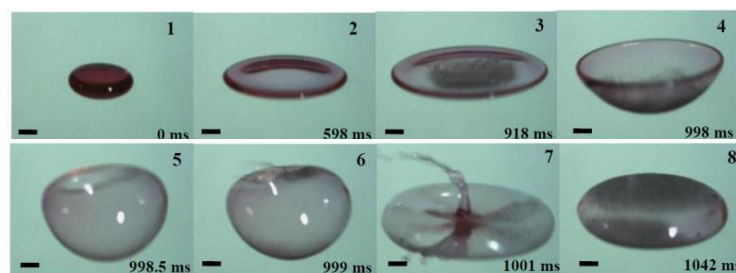Fig.1 Coalescence of nanoparticle-coated drops (liquid marbles) under acoustic levitation

Fig.2 Drop-to-bubble transition triggered by acoustic levitation

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Ion-mediated interaction between nanoparticles at the oil-water interface

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Keywords: Nanoparticle, adsorption, oil-water interface

Nanoparticles show huge potential for application in many industrial processes (material synthesis, drug delivery, enhanced oil recovery, etc.) because of their small sizes, huge specific surface area and easy surface modification. Nanoparticles which have specific size and surface functionalization can almost irreversibly adsorb at the oil-water interface, thus stabilizing the emulsions, i.e. Pickering emulsions. However, the mechanisms of nanoparticle stabilizing the emulsion are not completely revealed. It is widely accepted that nanoparticles kinetically stabilize emulsions, which is dominated by the adsorption ability of particle at the interface concerning with desorption energy and interplay between particles. In addition, many emulsion systems naturally contain ions, which have a significant influence on the adsorption of nanoparticle. Considering that an analysis of the interaction between nanoparticles at the interface is very crucial to understand the kinetic stabilization mechanism and nanoparticle assembly, we focus on the effects of ions on the interaction between nanoparticles at the interface and reveal its mechanism by using MD simulations.

We perform MD simulations using the LAMMPS package in the NVT and NPT ensemble. The initial simulation box are approximately $8.0 \times 8.0 \times 12$ nm^3. Periodic boundary conditions are applied to the x-, y- and z-directions. The PPPM method is adopted to calculate the long-range electrostatic force. The cut-off distance for all potentials is 1 nm. Silica nanoparticles with a diameter of 1.5 nm are used in all simulations. The monovalent and bivalent ions (Na$^+$、Ca^{2+}、Mg^{2+} and Cl$^-$) which are commonly seen in actual processes are dissolve in the water to simulate water phase with different salinity.

The results show that ions have the tendency to adsorb at the interface, especially divalent ions. Divalent ions (Ca^{2+} and Mg^{2+}) play a more significant role in the adsorption of silica nanoparticle at the interface on account of their strong electrostatic interactions with particle. With ion concentration increasing, more and more divalent ions aggregate at the surface of nanoparticle and enhance the electrostatic repulsion between nanoparticles at the interface, leading to a repulsion between nanoparticle at the interface and even causing the particle desorption from the interface. In addition, ions adsorbed at the interface have an inhibition effect on the diffusion dynamics of nanoparticle at the interface.

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Keywords: Cell-opening mechanism, Polymer foam, Interconnected porosity
Main Topic: Foams and emulsions

Interconnected open-cell polymer structures are required in various applications since they provide a specific performance to the final polymeric porous material [1, 2]. For instance, 3D polymer scaffolds for tissue engineering require open structures with interconnections not less than 5-10 times the diameter of the biological cells in order to ensure their viability and proliferation. Other areas include foamed materials for sound insulation whose performance is significantly enhanced with the increase of the interconnected porosity [2].

The open-pore content and interconnectivity are therefore very important parameters to be controlled in the manufacturing process. In order to be able to finely tune them, one firstly needs to improve our understanding of the complex mechanisms which govern the pore opening during solidification, including the correlation between the cell size and the size of the interconnections. In order to investigate these mechanisms in detail, we use the example of polyurethane foams. Pore opening during the formation of polyurethane foam is a highly complex phenomenon which depends strongly on the chemical formulation. Only little systematic literature is available on this subject [2, 3], relating it to urea precipitation [4].

In order to advance our understanding of these phenomena, we use monodisperse model PU foams with different chemical formulations which are generated using microfluidic techniques in order to obtain homogenous pore size and periodic pore organization. We use these foams to relate the pore opening mechanism(s) to the formulation (type and concentration of the surfactant, isocyanate content, catalyst concentration), the foam structure and to the solidification kinetics.
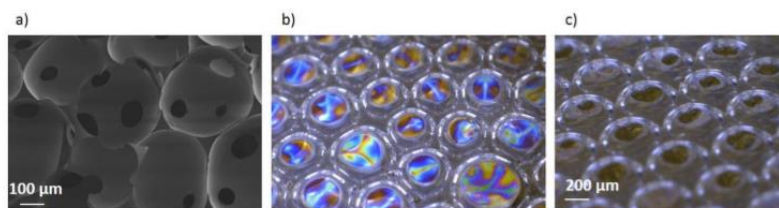

Figure 1: a) SEM images of interconnected PU foam structure. b) Closed-cell PU foams. c) Open-cell PU foams.

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Bubbles cavitation and propagation in micro-confined porous systems

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Keywords: micro-confined cavitation, bubbles ultrasound emission, bio-inspired device

Among numerous fascinating features, water can sustain high negative pressure and eventually relax its metastable state by nucleation of vapor cavities, a process named cavitation.

This study concerns experimental and numerical investigation of cavitation micro-confined in a porous material. The system is inspired by the fern sporangium that exploits negative pressure and bubble cavitation to activate an ultra-fast movement and eject spores as a catapult [1]. The key roles is played by its *annulus*: a cellulose beam-shaped structure covering half sporangium that encapsulates water in micrometric cavities. During the evaporation process, the *annulus* stores potential energy in the form of tensile water and opens its *stomium* containing spores. When bubbles suddenly cavitate and propagate along the whole beam, the sporangium releases all the energy with an ultra-fast closure of the annulus, performing an efficient spores' ejection. The realization and the investigation of a device mimicking the fern *annulus* can offer valuable insights to study cavitation in a controlled way as well as identify the determinants for its propagation to occur.

Our experimental device is made up of a 2D array of cubic cells containing water confined by methacrylate-based hydrogel [2]. This material faithfully reproduces the main features of the natural one: water loss induced by evaporation, water tension generation and bubble nucleation. Fast-imaging and acoustic measurements of bubbles nucleation events have been performed to shed light on the unique phenomenon of cavitation propagation. Our hypothesis is that cavitation propagate in the periodic structure because of bubble acoustic emissions. A bubble, nucleating in a confined system, oscillates before reaching an equilibrium [3] and hence it emits an acoustic wave. Its propagation triggers other bubbles in the neighboring cells resulting in an avalanche-like phenomenon. We were able to detect high-frequency signals for each nucleating bubble. We will present acoustic signatures in case of single and multiple cavitation events and will discuss the differences. Finally, we will show how water confinement and its geometry can affect propagation.

On the other hand, the numerical study focuses on the dynamics of a vapor bubble nucleating in a single cavity. The problem is addressed by means of a diffuse-interface formulation [4]: it enables the complete description of a complex vapor-liquid system and embeds surface tension, phase change and acoustic effects. The model cleanly captures bubble oscillations, acoustic emissions and their dissipation. Moreover, it allows for a reliable comparison with experimental results thanks to a modified equation of state that perfectly describes water behavior in both vapor and liquid phase.

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The effect of serum proteins on the dynamic interfacial properties of high-viscosity silicone oils

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We report a study of the effects of different serum proteins on the properties of the silicone oils /aqueous phase interface. High-viscosity (larger than 1000 cs) silicone oils (SO) are used in ophthalmology in a variety of surgical treatments targeting several pathological or traumatic vitreoretinal conditions, such as retinal detachments, haemorrhages, infections, etc. By a common surgical procedure, called vitrectomy, the vitreous body – the gel-like substance filling the cavity in the eye bulb, also known as vitreous humour – is replaced by transparent substitute fluids. In spite being one of the most utilised vitreous substitute, SO have a major drawback in its tendency to emulsify with the aqueous phase produced in the eye, which may result in a number of post-surgical complications from moderate to serious. At the present state of the art, in the long term, SO emulsification occurs invariably after a vitrectomy. Hindering such process represents thus an important benefit for these surgical treatments, in particular as related to the healing of retinal damages.

The blood proteins produced by inflammatory processes have been identified as one of the co-factors responsible for the emulsification. However, so far, the related studies are sparse [1,2,3] and do not address the core of the problem: how the adsorption of these proteins affects the dynamic properties of the interface, such as dynamic interfacial tension and the interfacial rheology, and how these properties are related to the SO emulsification. Filling such important knowledge gap represents a first mandatory step on the way to conceive and implement new strategies to hinder the emulsification of SO for vitrectomy.

To this aim, we have investigated the dynamic interfacial tension and the dilational rheology of the SO-aqueous phase interface in the presence of key serum proteins within the physiological concentration range. The corresponding measurements have been performed in the proper characteristic time windows by using a Drop Shape tensiometer. The results show that the adsorption of proteins at the liquid interface reduces the interfacial tension to values compatible with an increased tendency to emulsify and provides values of the dilational viscoelasticities compatible with a good stability of the resulting emulsions.

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effect of mixed cationic and non-ionic surface-active substances on kinetics of bubble attachment and quartz flotation

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Keywords: quartz; bubble; three-phase contact

Flotation is a physicochemical separation technique, based on selective attachment of air bubbles to hydrophobic solid particles. Bubble collision and attachment (three-phase contact - TPC - formation), is a fundamental step of this process. Timescale of the TPC formation depends on kinetics of drainage of a thin liquid film formed by the colliding bubble, i.e. liquid layer separating liquid/gas and liquid/solid interfaces. The TPC can be formed only if during the short time of the bubble-solid surface contact (a few milliseconds) (i) the liquid film reach its critical thickness of rupture, (ii) the hole of the TPC is formed, and (iii) the TPC perimeter expands enough to prevent a bubble detachment.

We report the results showing influence of concentration of n-cetyltrimethylammonium bromide (CTAB) and n-octanol pure and mixed solutions on kinetics of: (i) a single bubble attachment to the quartz surface, and (ii) flotation of quartz particles (micro-flotation tests). It was found that in distilled water and n-octanol solutions the TPC was not formed and the colliding bubble was not attached to quartz surface. Moreover, in the one-component (pure) CTAB solution of lowest concentration studied (c_{CTAB}=5·10^{-8}M) there was also no TPC formation. It means that the wetting films were stable in these systems. In CTAB solutions the TPC started to be formed above a threshold concentration $c_{CTAB} \geq 10^{-7}$ M. The t_{TPC} was decreasing with increasing CTAB concentration, what correlated very well with increase in the flotation recovery of quartz particles.

Advancing contact angle measurements revealed that within the concentration range $1·10^{-7}$ - $2·10^{-6}$ M the CTAB adsorption at the quartz surface was negligible. It shows that a preferential adsorption of CTAB cations at the bubble surface caused its charge reversal, from negative to positive, and the wetting film rupture was caused by the attractive electrostatic interactions between oppositely charged liquid/gas (bubble) and liquid/solid (quartz) interfaces. At higher concentrations, the CTAB adsorption at quartz surface was significant because the quartz contact angles were significantly higher. Higher hydrophobicity of the quartz surface facilitated the liquid film rupture, most probably due to a nucleation mechanism.

It was found that in the case of mixed CTAB/n-octanol solutions an improved flotation recovery of quartz was caused mainly by modification properties of the liquid/gas interface by n-octanol molecules adsorbed at the bubble surface. In the CTAB/n-octanol mixtures, n-octanol was entirely responsible for shortening the time of the bubble bouncing, while CTAB molecules, co-adsorbed at the bubble surface, caused the bubble surface charge reversal (from negative to positive), necessary for the wetting film destabilization.

Dodecane in water emulsions stabilized by sds: adsorption properties and emulsion behaviour

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The lifetime of emulsions is a crucial parameter for a wide range of industrial applications. In this work, we investigated the destabilization of a typical oil in water emulsion by a multi-technique approach, which allows the deepening of the mechanisms involved in the process. Aim of this study is a better understanding of the different destabilization phenomena in order to have the possibility to tune the desired properties of the emulsions.

In particular, we investigated dodecane in water emulsions stabilized by sodium dodecylsulfate (SDS), being this system of special relevance since SDS is one of the most used ionic surfactant.

Our approach includes different type of characterizations, from the basic study of the adsorption of SDS to the dodecane/water interface, to the long-time monitoring of the stability of the emulsion. Along this line, we measured the surface tension and dilational rheology of the interfacial layer versus the SDS concentration and studied the emulsion features by DLS and conductivity measurements. Direct drop-drop coalescence experiments have been also performed.

From the results of this characterization combined with the information from the evolution of the relative emulsion height with time, it was possible to formulate hypothesis on the different mechanisms taking place during the destabilization process, like for example, creaming, coalescence or ripening.

More specifically, it was found that the system studied here provides remarkably stable emulsions already at low surfactant concentrations. Coalescence process in these emulsions is hindered due to the ability of SDS to reach high values of the interfacial coverage. Therefore, the destabilization of emulsions is mainly driven by creaming and Ostwald ripening.

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Keywords: Liquid foam, Coarsening, Coalescence

Main Topic: Foams and emulsions

Foam destabilisation is crucial in many industrial processes such as food-processing or detergency. There are three processes leading to foam destabilisation: liquid drainage (gravity-driven liquid flow), coalescence (merging of two bubbles) and coarsening (gas transfer between neighbouring bubbles of different pressure). In a 3D foam, these three processes are interdependent and it is difficult to disentangle them. A way to separate drainage from coalescence and coarsening is to use horizontal quasi-2D-foams, which, in our case, consist of a monolayer of bubbles sandwiched between two horizontal plates. In this geometry, we can study coarsening, coalescence and the competition between both processes. If the coarsening is very well described in 2D-foams, the coalescence is poorly understood. There are many hypotheses to explain coalescence. Among them, one can cite a critical liquid fraction[1], a critical bubble size [2] or a critical capillary pressure [3].

To discriminate between these different mechanisms, we have built a 2D cell in order to control the liquid fraction in the 2D foam based on an experiment realized by Roth *et al.* [4]. We use direct visualisation to monitor the evolution in time of various foams, both monodisperse and polydisperse, at different liquid fractions and bubbles' size.

First, we show that the topology of a coalescing foam is very different from the one of a coarsening, but non-coalescing, foam. We quantify this difference using the averaged bubble convexity. This allows us to determine the time at which a cascade of coalescence starts in the foam. We show that this time increases with the foam humidity.

Using the 2D-foam, we also tested the three main hypotheses of coalescence by tracking bubbles and by measuring the correlation between the breaking of a film and the rearrangements in the foam.

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Emulsion morphology and dynamics by combined DWS and optical microscopy

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We report recent results obtained investigating oil in water emulsions, with variable liquid proportions and different contents of surfactant (SDS), exploring both the low surfactant concentration (0.01-1 CMC) and the high surfactant concentration regimes (1-10 CMC). We combine the analysis of DWS correlation functions simultaneously measured in transmission and backscattering geometry (left panel) with direct observation and optical microscopy digital image processing. In particular, at early aging, as a function of surfactant concentration we observe the dependence of droplet size distributions (central panel) and we focus on droplet polydispersity, which has dramatic impact on emulsion stability (independently measured on the same emulsions). Within the limits of each technique, we obtain numerically consistent results for average droplet radius (right panel) with no adjustable parameter, proportionality factors being deduced from literature [1]. Results are discussed in view of soluble surfactant adsorption models.
By DWS we also follow aging effects [2], deduce power law dependences, and infer some expectations for future microgravity experiments. In view of these, we also explore the effects of different emulsification procedures (Ultraturrax vs syringe) on emulsion stability and dynamics. Finally, time permitting, we shall present some preliminary results on the morphology and dynamics of compressed foams, across the ranges of homogeneous fluid mixture to the separation of gas and liquids.
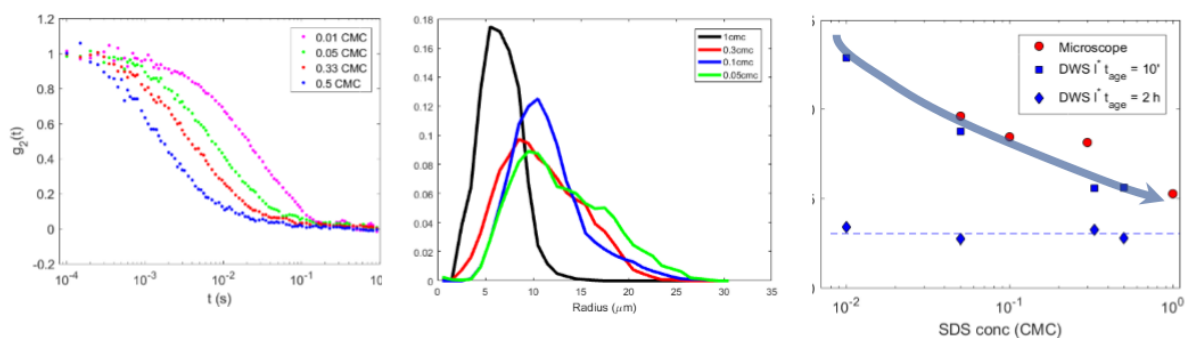
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Keywords: Please microfluidic, bubble, lubrication film

Droplet-based microfluidics is a growing field often requiring an accurate synchronization for automated systems. The question we address is the prediction of a bubble velocity pushed by a surrounding liquid set at a fixed mean velocity. Our understanding of the dynamics of traveling bubbles or droplets in confined geometries has been steadily refined since the pioneering work of Taylor and Saffman, who derived analytically the velocity of a quasi-2D bubble using depth-averaged Hele-Shaw equations [1]. All the refined reported models, which take into account the dissipation at the meniscus, are 2D [2]. However, predicting accurately bubble velocity calls for a full knowledge of the dissipation mechanisms at play, which requires determining the full 3D profile of a traveling bubble, mostly close to the walls. The experimental set up is a microfluidic system in which bubbles flow in fluorinated oil (FC-40) in a Hele-Shaw geometry in a total wetting case, i.e. there is a lubrication film of fluorinated oil between the bubble and the wall. We reported recently an experimental set up enabling the measurement of lubrication film thickness with an accuracy of 2 nm [3]. In the present work, we discuss the complex shape adopted by the traveling bubble and formally link this topography to the bubble velocity. We propose a model that takes into account both the viscous dissipation in the menisci and the 3D topography of the lubrication film [4]. Remarkably, this model allows recovering the experimental bubble velocity without any fitting parameter.
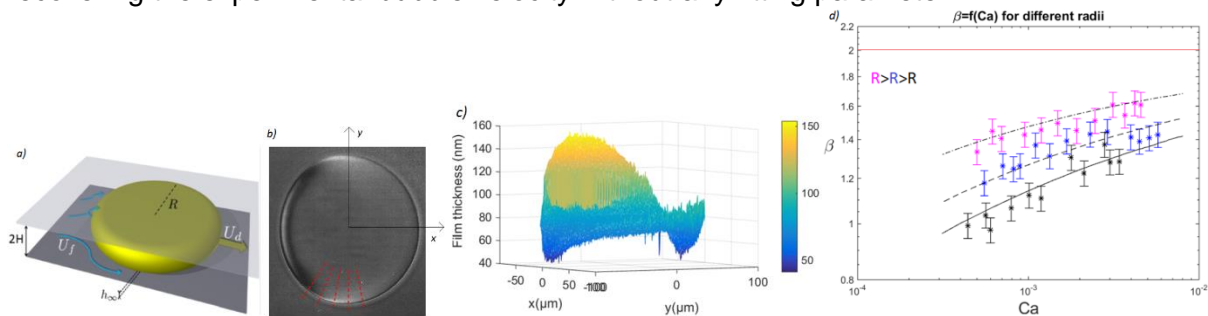
a)Picture of Hele-Shaw bubble of radius R traveling in a Hele-Shaw cell of thickness 2H. U_f and U_d are respectively the external fluid and the bubble velocity. h_∞ is the lubrication film thickness at the center of the bubble; b) Experimental picture of a C6F14 droplet translating in a Hele-Shaw cell . Its diameter is 180 µm. d) Experimental film topography. d) Experimental mobility $\beta = \frac{U_d}{U_f}$ as a function of the capillary number Ca for different bubble radii. The dashed, dotted-dashed and solid line correspond to the model. The red solid line is Taylor and Saffman model.

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Effect of inner phase on size distribution of bubble or drop breakup

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Keywords: bubble & drop breakup, bubble size distribution, turbulent flow

Breakup of bubbles or drops in a turbulent liquid is one of crucial processes controlling the behaviour of multiphase systems. Most of the breakup models (reviewed e.g. by Liao, 2009; Solsvik, 2013) predict the breakup frequency and size distribution of daughter particles in dependence on the local rate of energy dissipation and particle size, but do not consider the flow of internal phase. In contrast, experiments suggest that the particle breakup in turbulent flow significantly depends on the properties of the internal phase (Andersson, 2006).

Present model predicts the outcome of breakup of a fluid particle (bubble or drop), which is initially deformed and breaks into two daughter particles. An initial deformation of the particle (e.g. due to turbulence) is assumed in a shape of dumbbell with two spherical parts connected with cylindrical neck. The evolution of sizes of particle sub-parts is calculated using Rayleigh-Plesset equations, which consider the inertia of surrounding liquid, capillary action and viscous effects. The redistribution of internal fluid in the particle is calculated estimating pressure drop in the connecting neck.

The model computes the sizes of daughter particles after the breakup. Assuming the random initial conditions (various initial shapes and initial velocities of deformation), the size distribution of daughter particles is obtained. These size distributions are qualitatively compared with available experimental data and reasonable agreement is observed.

Because of restricting assumptions, this model cannot be used directly for accurate prediction of size distribution after a breakup. However, it provides an insight in the effect of properties of the inner phase on the breakup. The model suggests that the redistribution of the inner fluid is an important feature, which controls the size distribution of daughter particles in turbulent breakup and which should not be neglected in breakup modelling.

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Dispersed bubbles for soil flotation in continuous column

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Particulate flotation foams are of great interest in mineral processing, water treatment and radioactive soil remediation (Faure and Messalier 2013). A new instrumented flotation column that is halfway between the pilot and the lab scale developed in our laboratory is presented. This installation works in continuous mode and allows both bubble size distribution and gas hold up measurement in the slurry. The air bubble size in the collection region was determined using an intrusive bubble sampling technique (Randall, Goodall et al. 1989; Grau and Heiskanen 2002) constituted of a 1 cm diameter and 80 cm long pipe filled with deionized water and 4 mg L-1 of free TTAB (non-coalescing liquid) that is immersed in the pulp.

In the present study supported by the French Agence Nationale de la Recherche through DEMETERRES project (especially AREVA partner), it is applied in the context of radioactive soil decontamination to extract with air bubbles clay particles such as illite. Indeed, it has been demonstrated that at low concentrations radioactive Cs sorbs strongly on micaceous minerals such as illite (Poinssot et al, 1999). To capture clay particles by attachment to dispersed bubbles in the column, a cationic surfactant (TTAB) is used to adsorb on the negatively charged clay particles surface. The surfactant modifies the hydrophobicity to different extents depending on initial concentration in the slurry. We studied the influence of TTAB/clay mass ratio on flotation performances, bubble size distribution and gas hold up. Consistent and reproducible data were obtained. The flotation rate constant increases with the TTAB/illite ratio whereas bubble size decreases. Gas hold up measurements underlined an accumulation of small bubbles at the highest TTAB/illite ratio tested due to their small buoyancy. Preliminary results on the capacity of these bubbles to capture negative particles from real soils samples will be presented and discussed.

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Dynamics of a fibre-laden foam

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In the past few years there has been a renewed interest in the use of a liquid foam rather than water as a carrier fluid for wood fibres in papermaking: using fibre-laden foams considerably reduces the water consumption and the energy required by the drying step. It might also allow a better control of the properties of the final dry fibre network. Recently a few experimental studies have explored the influence of the fibres on the static and dynamic properties of the bubbles and foam: incorporating fibres within a foam leads to smaller bubbles, higher liquid fraction and higher viscosity. However, there is still a lack of fundamental understanding of the dynamics of such a three-phase system.

To further explore these dynamics we have performed numerical simulations, based on a discrete-element approach, in which we model the behaviour of flexible fibres within a 2D liquid foam under shear. We first address the issue of the dynamics of a single fibre, and show that the presence of bubbles is not enough to inhibit the tumbling motion of the fibre, that is commonly observed in a newtonian fluid. We then study the influence of fibres on the rheological properties of the foam, depending on the volumetric concentration of fibres, their stiffness and length, and their surface properties (smooth or sticky).

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An antibubble is a shell made of a gas phase surrounded by a liquid phase. Most of the time, in the literature, this object is made of soapy water. At the opposite of bubbles however, the surfactant molecules do not aim at inducing an electrostatic repulsion between their heads because the phases are inversed. The confinement of these molecules does not even produce Marangoni flows that oppose drainage in soap bubbles. The role of the surfactant is yet of importance. In the case of antibubbles, the tails of the surfactant molecules help to avoid the action of hydrogen bonds and provide surface viscosity and elasticity to the interfaces, slowing the drainage of the air film.

Here, we show that surfactants are not necessary to obtain antibubbles as defined above. Indeed, opposing the drainage is not the only way to avoid the collapse of the gas film between the inner drop and the outer liquid phase at the south pole of the antibubble: a production of gas at this location can feed the gas film enough.

Due to the Leidenfrost effect, a drop at its boiling temperature can levitate above a substrate at a temperature larger than this boiling temperature, because of equilibrium is reached between between the drainage of the vapour film and its production due to the conductive heat transfer from the substrate to the drop. It was recently showed that this effect can occur on substrate at temperatures as low as the boiling temperature of the liquid of drop [1].

Using this effect, we experimentally impact millimetric drops of volatile liquid (HFE-7100, ethanol…) on pools made of silicone oil at temperature comprised between the boiling temperature of the drop and 160°C and produce antibubbles made of an inner drop of a volatile liquid, a shell of (almost) pure vapour, and a surrounding phase made of hot oil.

A model is developed to explain the drainage and production of vapour in these objects, based on previous models validated for antibubbles made of soapy water. The appearance of a large pocket of vapour above the inner drop is explained.

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PMDS: a molecular coating that hides defects and slows drops

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Keywords: hysteresis, contact line dynamics, viscoelasticity,

Typical solid surfaces exhibit a contact angle hysteresis of a few degrees at best. This is known to arise from the pinning of the three-phase contact line on defects on the surface. The dynamics of the contact line are expected to be driven by a combination of thermally-activated motion over these defects and of hydrodynamics. In contrast, we have found that the presence of a molecular layer of polydimethylsiloxane (a PDMS pseudo-brush) can substantially reduce the hysteresis and that the dynamics become dominated by the viscoelasticity of the layer [1].

By the addition of known topographical defects on the surface and the use of liquids that are either solvents or non-solvents of PDMS, here we show how the swelling the pseudo-brush plays an important role in reducing the hysteresis. An illustration of this is given in figure 1, which shows the hysteresis as a function of the number density of defects, the slope of which gives the energy dissipated over one defect. Comparison to a molecular coating that does not swell (octadecyltricholorsilane, OTS) shows that defects are hidden only in the case of a swollen layer. We also compare the wetting dynamics using good or poor solvents and with PDMS of different polymerization indices N, thus changing the thickness of the resulting layer. We find, for example, that the dynamics are slower for larger N, although the viscoelastic contribution is still large for layers as thin as a few nanometers.
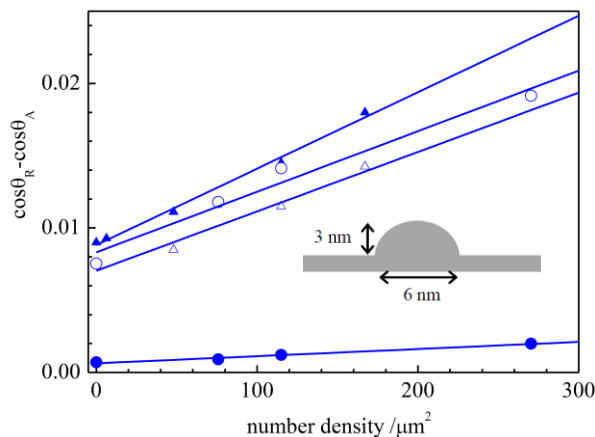
Figure 1: The contact angle hysteresis $H/\gamma = \cos\theta_R - \cos\theta_A$ obtained from the receding and advancing angles. The surfaces are PDMS $N = 126$ (circles) and OTS (triangles), each shown with a good (filled) and a poor (open) solvent. The inset shows the size of the defects.
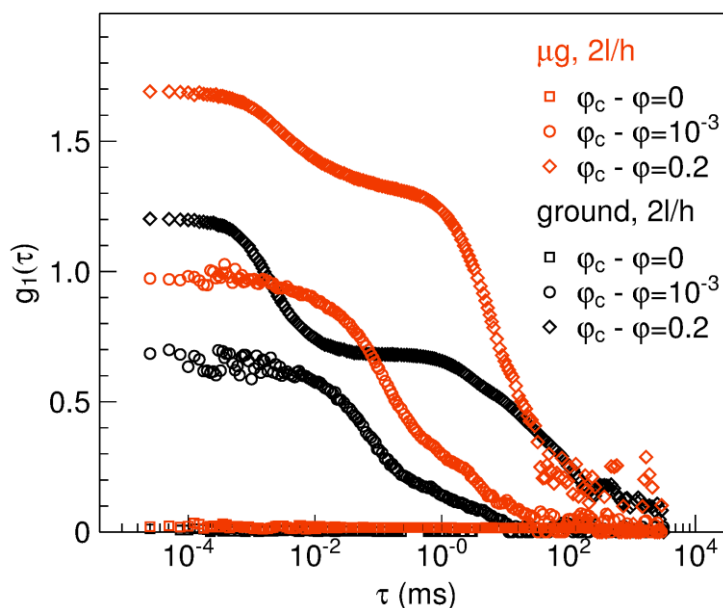
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Keywords: rheology, amorphous solid, light scattering

The derivation of rheology is shown for particulate systems. The predicted flow curves connecting shear rate with shear stress are applicable for a driven granular or a bubbly liquid. The extension to even denser systems is discussed. The presented description is based on both the description of an amorphous solid emerging from a system of dissipative, e.g. granular, particles [1, 2] and the earlier theory for colloidal rheology [3].

The theory part is complemented by a discussion of light-scattering techniques devoted to measuring time-correlation functions in such disordered particulate systems both quiescent and sheared [4]. In order to achieve a sedimentation-free homogeneous test case, some experiments are performed in microgravity [5]. The figure below demonstrates differences observed for a system fluidized by a stream of air of 2l/h on ground and in microgravity, respectively, for varying packing fractions φ close to full arrest at φ_c.

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Encapsulation of vitamine E by water soluble polymer–surfactant mixtures

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Keywords: adsorption, emulsions, capsulation

Polymer/surfactant mixtures have a wide range of industrial and technological applications and their specific behavior was studied at liquid/gas, liquid/liquid and liquid/solid interfaces. In particular, this is clearly seen in metastable micrometer and sub-micrometer heterogenous disperse systems, such as foams, emulsions and dispersions. Among them, the use of emulsions stabilized by polymer−surfactant mixtures in the microencapsulation of a variety of volatile components, such as perfumes, or flavors, is a promising route in a wide range of applications in home and personal care products, cosmetics, foods, and pharmaceuticals.

Due to the electrostatic interaction with oppositely charged ionic surfactants, polyelectrolytes can form complexes which modify the interfacial properties and affect the emulsion stability. By changing the polyelectrolyte/surfactant concentrations ratio, it is possible to change the charge of emulsion droplets which is important for further steps of the encapsulation procedure.

The main objective of this work is to study the encapsulation of vitamin E (alpha-tocopherol) by a layer-by-layer (LbL) multilayer method depending of different wall compositions. As wall material, mixtures of the anionic polyelectrolyte PSS with the cationic surfactant CTAB as a first layer, then LbL assembly of oppositely charged chitosan, and then PSS were used. The optimal conditions (conditions of emulsification, layering, encapsulation etc) were determined. The stability of emulsions and microcapsules (charge and size distribution) were studied by dynamic light scattering. The size distribution of initial emulsions, intermediate and final microcapsules was measured directly after emulsion formation by using a Zetasizer (Malvern), and repeated over a time period of 10 days. The results show good stability of the capsules and their sizes were around 1-1.5micron with a PDI=0.3. The sizes of capsules were confirmed by Cryo-SEM and confocal microscopy. The Zeta-potential of the investigated capsules changed from -45 mV to +40mV in each layering. The Zeta potential value of the final capsules were -40mV, which provides good stability effects.

Innovative process for precise size control of emulsion production at pilot scale

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Keywords: emulsion size reduction; membrane emulsification; pilot scale

Membrane processes are increasingly used for different applications with the aim of process intensification (e.g. reduced energy consumption, easy scale-up, mild conditions, ect). For example, membrane techniques have been increasingly reported these last years for the preparation of emulsions, double emulsions and a large range of colloids such as microspheres and microcapsules [Charcosset 2012]. Membranes can be used for emulsification either in direct membrane emulsification or premix membrane emulsification. In this last technique, large droplets of coarse premix are disrupted into fine droplets by utilizing a microporous membrane. Premix membrane emulsification holds several advantages over direct membrane emulsification [Vladisavljević et al. 2004]: (1) the flux can be much higher than in direct membrane emulsification, (2) the mean droplet sizes are smaller than in direct membrane emulsification with a droplets/ pore ratio equals to 1 or less, (3) the experimental set-up is simpler than in direct ME, e.g. no pump or stirrer are needed, except for the preparation of pre-emulsion, (4) less membrane fouling is obtained and membrane cleaning is easier.

In this study, we investigate the continuous production of emulsions by premix membrane emulsification at high flowrates (up to 200 mL/min). The process can be operated at constant pressure or constant flowrate. The size of the emulsions obtained is measured by laser diffraction. The influence of both formulation (interfacial tension between the dispersed and continuous phases, amount of dispersed phase, dispersed phase viscosity …) and process parameters (flowrate, pressure, membrane length…) on the emulsions obtained (size distribution, stability, etc) is investigated.

Overall, it is shown that the process can be operated at high flowrates for the production of emulsions with controlled size distribution. The technique could be an alternative to other emulsification techniques at pilot scale for industrial emulsification.

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Influence of Bubble size on reactive mass transfer at sigle free-rising bubbles: a numerical analysis of mass transfer coefficient and selectivity

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Keywords: rising bubble, reactive mass transfer, selectivity

Main Topic: Bubble & drop in industrial applications

In bubble column reactors with low void fraction (dispersed flow) the reactive mass transfer processes of the quasi-isolated bubbles are, mainly, dependent on the bubble size, i.e the diameter, and the associated shape and dynamics. Since an efficient scale-up of these devices should ensure high rates of mass transfer and, at the same time, reduce the formation of side products, it is beneficial to detect an optimal range of bubble sizes leading to high mass transfer coefficient and reaction selectivity.

The present study has been carried out by means of Direct Numerical Simulations based on the Arbitrary Eulerian-Lagrangian Interface-Tracking approach. Detailed simulations have been performed, considering 3D effects, deformable interfaces and transport resistances in both the phases. An auxiliary mesh is generated from the grid used for the hydrodynamic problem in order to provide sufficient resolution for an accurate solution of the species transport in the concentration boundary layer region.

A competitive-consecutive reaction mechanism has been considered, that is of prototypical type for many different industrial applications. Particular attention has been paid to the understanding of the changes in the global mass transfer coefficient and selectivity through the analysis of the corresponding local fields.
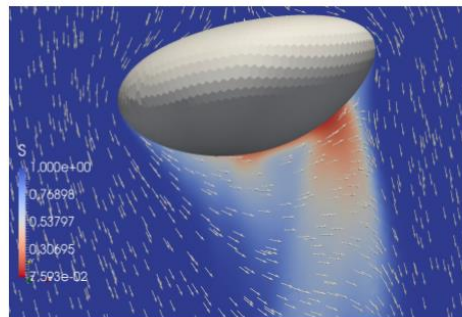
Fig. 1: Local selectivity competitive-consecutive mechanism for d_b=3.86 mm

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Drop transport and positioning on lubricant impregnated surfaces

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Lubricant-impregnated surfaces (LIS) have been shown to exhibit excellent water-shedding performance [1,2] with droplets placed on these surfaces having highly mobile contact lines. These surfaces enable droplet mobility and propulsion studies due to the removal of direct contact between the droplet and the underlying solid surface [3,4]. Here we demonstrate the transport and positioning of water droplets on a macro-patterned surface, impregnated with a lubricating liquid using a nano-particle based superhydrophobic coating [5]. We achieved droplet self-propulsion using shallow V-shaped channels rendered as LIS (Figure 1a,b). We found that a migration of droplets arises from the interaction between the droplet and the lubricant layer via a capillary mechanism similar to the Cheerios effect [5,6]. Out of equilibrium droplets self-propel to different types of equilibrium positions on the surface with both local and global equilibriums being observed. We provide a capillary-based mathematical model to quantify the transition from local to global equilibrium and show that the latter is due to a force balance along the apparent contact line of the droplet [5]. Beyond the V-shaped geometry, we also highlight possible applications where lubricated macro-patterned surfaces can be used to control the motion and positioning of droplets.
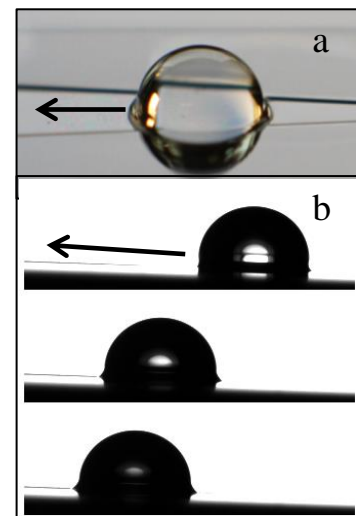
Figure 1. a. A droplet on a V-shaped channel b. A droplet moving uphill on top of a V-shaped channel at 2° tilt angle.

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Keywords: Electrowetting, dielectrowetting, lubricant impregnated surface

Electric fields are important in manipulating and controlling droplets. Two of the approaches are electrowetting, which manipulates the ions in a conducting liquid droplet at the solid-liquid interface and stores capacitive energy by the polarization of a solid dielectric layer [1], and dielectrowetting, which manipulates dipoles in a dielectric liquid droplet at the solid-liquid interface to store capacitive energy by polarizing a liquid dielectric layer [2]. However, a major limitation of electrowetting is its inability to spread a droplet to a film state. Dielectrowetting can induce droplets of dielectric liquids to spread or superspread into a film state [3]. However, in both the electrowetting and dielectrowetting approaches the solid surface causes contact angle hysteresis due to pinning forces at the contact line. Here, we report the forced spreading and subsequent retraction of droplets on lubricant-impregnated surfaces (also known as slippery liquid-infused porous surfaces, SLIPS [4,5]) where the contact line is completely mobile. We confirm that electrowetting on a SLIP surface obeys the modified Young's law for electrowetting but with no hysteresis [6] (see also [7]). Moreover, we show that dielectrowetting with very low levels of hysteresis can be achieved, when spreading between a droplet and film state, in a completely reversible manner. We show good correlation with theoretical expectations and without a breakdown of the lubricant impregnated surface [6].

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Study of factors influencing the formation of oil-in-water microemulsions

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In order to design new materials with predefined properties it is important to know the properties of initial materials. Emulsions are very widely used materials. Choosing of type of emulsion depends on the field of application. It is possible to obtain containers by mean of emulsification.

Here, we studied the process of obtaining the oil-in-water emulsion system 3-(trimethoxysilyl) propyl methacrylate/ silica dioxide / water [1,2] in order to obtain containers to encapsulate different agents [3]. In order to study the thermodynamic factors in the emulsion formation [4,5] the interfacial tension at the oil-water interface was investigatedusing profile analysis tensiometer (Tensiometer PAT-1), as well as influence of introduction of active agent in the oil phase on contact angle value (Kruss G-10), andthe influence of oil/nanoparticle weight ratios on the size distribution (by DLS) , shape and morphology (SEM, TEM).

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The complex interaction of foams with porous substrates was investigated recently for the first time by us [1]. Foam drying under terrestrial condition proceeds under the combine action of both gravity and capillarity. The gravity forces the liquid to move from the top of the foam to the bottom and it is the only driving force of drainage. Gravitational drainage is the main tool used to dry the foam under terrestrial conditions. However, the gravity action is negligible under microgravity condition (for example inside a spacecraft). In this case drying the foam is difficult and it is necessary to find a completely new way of arrangement of the drying process. Below a new foam drying process is suggested which is based on the completely new physical phenomenon: capillary suction of the liquid from the foam by a porous body in contact with the foam [2].

Let the initial water content inside the foam is φ_0 and the average water content inside the foam at the moment t is $\varphi(t)$. It is possible to write down the mass conservation law of water at the moment t in the following form:

$$\pi a^2 H \varphi_0 = \pi a^2 H \varphi(t) + \pi R^2(t)\Delta p ,$$

(1)

where Δ and p are the thickness of the filter paper and the porosity, respectively.
From Eq. (1):

$$\varphi(t) = \varphi_0 - R^2(t)\frac{\Delta p}{a^2 H} .$$

(2)

According to Eq. (2) the water contents $\varphi(t)$ decreases over time until a final water content is reached, which is determined by the relation between the capillary pressure inside the foam and the capillary pressure inside the porous substrate (filter paper, for example). If the desired final water content is φ_f then it determines the moment, t_f. At this moment the imbibition into the porous substrate should be interrupted (that is, the filter paper should be removed):

$$\varphi_f = \varphi_0 - R^2(t_f)\frac{\Delta p}{a^2 H} .$$

(3)

The total duration of the drying process can be easily controlled by a proper selection of the thickness, porosity and capillary size of pores inside the filter paper.

The current state of the studies on drainage kinetics will be presented and the experimental study of foam drainage under simulation of microgravity conditions will be discussed.

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Keywords: Foam, Snap-off, EOR

Many secondary and tertiary oil-recovery schemes use gas to displace oil towards a producing well. Gas-injection processes in porous media, however, are often cursed by unfavourable mobility ratios and differences in fluid densities, leading to a poor sweep efficiency. Foam, which is a distribution of discontinuous gas bubbles in a continuous liquid phase, can help significantly reduce gas mobility by "viscosifying" the gas, giving a better sweep efficiency. In homogeneous porous media, experiments show that foam generation can be triggered by exceeding a critical velocity or pressure gradient. Such pressure gradients are usually encountered near a well. Away from a well, this may not be the case and it is uncertain whether foam can still exist and propagate. Previous work has shown that foam can be created in a liquid-saturated medium as gas travels across a sharp permeability increase even at low pressure gradient. Accounting for heterogeneities in mobility reductions during a foam flood can improve the chances of success of a foam EOR project. We extend previous studies by, first, demonstrating similar observations with different injection strategies and initial porous-medium conditions. Further, we investigate local pressure gradient measurements and X-ray computed tomography images for experiments performed on an artificial porous medium made out of sintered borosilicate glass. We perform coreflood experiments with simultaneous injection of gas and surfactant solution into the model porous medium, which has a sharp permeability change. The C14-16 alpha olefin sulfonate (AOS) surfactant was selected to stabilize foam. The permeability change represented in the synthetic core is analogous to small-scale heterogeneities, such as cross-laminations, as encountered in reservoir formations. Low flow rates are used to ensure that capillary snap-off at the heterogeneity is the only mechanism responsible for foam generation in the core. This is verified through pressure gradient measurements. The effects of the magnitude of heterogeneity and injected gas fractional flow on foam generation were investigated. CT images were used to further visualise the process of foam generation and mobilisation and to map liquid saturation over time during a foam generation experiment. We show that local changes in saturation and pressure mark the onset of foam generation. Additionally, we demonstrate a fluctuating behaviour in pressure gradient across the permeability transition, suggesting cyclic plugging and mobilization of foam there.

Tracking the surface composition of a covered air/liquid interface by non-linear optics

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Keywords: amphiphilic molecules, adsorption and organisation, non-linear optics

Features of **amphiphilic molecules at interfaces** are of crucial interest to understand lipidic membrane or macroscopic foam properties. For example, literature [Koehler] shows that one can change the rigidity of a soapy interface, and thus a foam life-time, only by a little change in the formulation of the soapy solution (e.g. addition of a small amount of dodecanol in an aqueous solution of SDS). If the link between microscopic and macroscopic properties of covered interfaces is well established, it is not always well understood essentially because of the lack of techniques that gives access to the **composition and the dynamics of such interface at molecular scale**.

Second Harmonic Generation (SHG), a peculiar case of non-linear optics, is a surface sensitive technique: SHG signal is generated only where centro-symmetry is broken, then at interfaces and not in the bulk. SHG is thus **a tool of choice to study the behaviour of amphiphilic molecules adsorbed at air/water interfaces**.

We will first present the principle of SHG experiments.
Recent results obtained by SHG on the composition and organization of adsorbed amphiphilic molecules on air/water interfaces at a molecular scale will then be presented [Bonhomme, Bruyère]. Those results will be confronted to other experimental characterizations (surface tension measurement, disjoining pressure, …) and to literature.
We will finally focus on the use of SHG experiments for studying interfacial phenomena, like aggregation process. We will present results on the determination of surface aggregate size by "Surface SHG Fluctuation Correlation Spectroscopy" [Gassin] and on their structure through SHG experiments resolved in polarisation [Bruyère].

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Keywords: Coffee ring effect, Droplet evaporation, Porous substrates

It is well know that evaporation of a colloidal dispersion droplet, placed on a flat solid surface, leads to accumulation of colloidal material near the 3-phase contact line [1]. A similar phenomenon is observed when the droplet is placed on a porous substrate, where the droplet is firstly completely imbibed, and thereafter gradually evaporated. In this case, the colloidal material is seen accumulated near the periphery of the wetted area on the porous substrate at the end of evaporation [2]. Although coffee ring formation on flat solid surfaces is well understood, the corresponding phenomenon on porous substrates is still not very well elucidated. A good understanding of this phenomenon is desired due to its widespread relevance in numerous applications including inkjet printing, dried spot sampling of biological samples and the application of several personal and home care formulations. in this work, the formation of coffee rings on porous substrates has been experimentally investigated.

For the experimental investigation, dispersions of cationic esterquat vesicles, which are commonly used in fabric softeners, were used as model colloidal dispersions. Samples of cellulose fiber filter paper with different porosity levels were used as porous substrates. A droplet of fixed volume was placed on the porous substrate, and the evaporation process was observed from the top. The evolution of the form of the wetted area with evaporation time, as typically observed, is shown in Fig. 1. The final coffee rings obtained in different experiments were compared with each other in order to obtain insights into the influence of different factors such as porosity, presence of electrolyte in the bulk liquid, and phase behaviour of the bilayers constituting the vesicles. It has been observed that the coffee ring effect is stronger at high porosity and in the presence of electrolyte in the bulk liquid. Furthermore, vesicles with liquid-crystalline phase bilayers are found to produce stronger coffee rings than those with solid-gel phase bilayers.
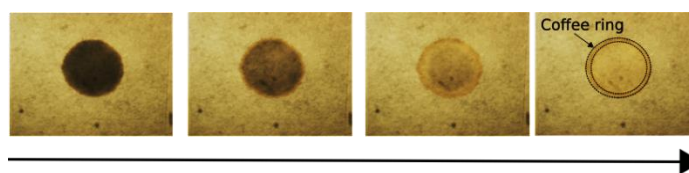

Fig. 1 : Evolution of the wetted area during evaporation leading to coffee ring formation

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Effect of cholesterol on liposome membrane permeability: application to corticoids

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Keywords: corticoids, liposomes, permeability

Corticoids are steroids known for their anti-inflammatory and immunosuppressive effects. Cortisol, a well-known corticoid, is the natural hormone produced by the adrenal cortex and its bioavailability is reduced by the first-pass hepatic metabolism. Methylprednisolone (MP) is a synthetic corticoid which differs from cortisol by a methyl group at the C6 position and is about 5-fold more potent than cortisol. This study focuses on the effect of corticoids on membrane permeability using fluorescent release from liposomes used a model membranes. A specific attention is devoted to the effect of cholesterol (CHO) on the controlled release of the florescent dye. Indeed, CHOL is a key component of eukaryotic cell biological membranes which has key effects on the rigidity, thickness, permeability, stability and fluidity of lipid membranes (Takechi-Haraya et al., 2016).

Large unilamellar vesicles (LUVs) encapsulating 2.5% of corticoids are prepared by reverse phase evaporation technique. They are composed of dipalmitoylphosphatidylcholine (DPPC) and CHOL in different DPPC:CHOL ratios of 100:0, 100:10, and 100:30. In order to investigate the effect of CHOL content on the bilayer permeability of corticoids-loaded liposomes, the different liposomal suspensions encapsulating a fluorescent dye, sulforhodamine SRB, were compared for the leakage of the fluorophore through the lipid bilayer at 37°C over 48 h. In parallel, the SRB release kinetics data were fitted to various mathematical models such as first order, Higuchi and Korsmeyer-Peppas models.

On the overall, the SRB release kinetics decreased with the increase of CHOL content. Results showed that MP and cortisol affect the bilayer permeability of liposomes devoid of CHOL and the release kinetics of SRB was higher that 96% over 83±0.02% for blank liposomes. With increasing the cholesterol content, the effect of MP on DPPC bilayer permeability was higher than cortisol. The SRB release kinetics from MP-loaded liposomes encapsulating 10 and 30% CHOL reached around 71±0.66 and 40±0.31% respectively, 67±0.01 and 23±0.48% respectively from cortisol-loaded liposomes over 63±0.26 and 21±0.05% from blank liposomes. Mathematical models showed that the release kinetics of SRB was found to be best-fitted by Higuchi and Korsmeyer-Peppas models. In addition, the mechanism of release of SRB from corticoid-loaded liposomes is controlled by several mechanisms such as diffusion, erosion and/or relaxation mechanisms.

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Stable and easy biodegradable particle stabilized wet foams

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Keywords: foam stability, colloidal particle, silica particle, lauryol ethyl arginate, chitosan, particle hydrophobization,

Aqueous foams are extremely complex systems with a cellular internal structure, consisting of polydisperse gas bubbles separated by thin liquid films. Foam evolution and its transient stability are functions of drainage and rupture of liquid films between air bubbles. The rate of foam drainage also depends on the surface rheological properties of the adsorption layers at liquid interfaces.

Our aim was to develop a new easy degradable aqueous foams for various, industrial and/or biomedical application. The specific objective was to find correlations between surface activity, surface elasticity and foaming properties of cationic surfactant lauroyl ethyl arginate (LEA) and colloidal silica nanoparticles (Levasil).

Main foaming test were performed in a glass foam column. Additional experiments were performed in the equilibrium conditions in the Scheludko-Exerowa micro-interferometric thin liquid film instrument. Drop profile analysis tensiometer was applied to measure the time evolution of surface tension and surface dilatational viscoelasticity. Confocal microscopy lead us to study in detail the ageing evolution of the thin foam film in real dynamic conditions.

It was found that due to partial hydrophobization of the silica particles (by LEA) and presence of additional electrolyte some nanoparticles (initially size 10-20nm) aggregate and precipitate. However, during further foaming process those aggregates could be incorporated into the space of thin foam film via froth flotation process. They act there as a big plugs (800-1200nm of aggregate diameter), which inhibited the drainage processes. In the contrary, smaller particles (size below 10nm of diameter) in such ionic strength/hydrophobization conditions did not aggregate and stayed in the bulk of the solution. Confocal microscopy observations proved that after the foaming process such particles could be attached at foam

film interface and block coarsening and/or coalescence of foam cells.

Voltage sensitive second harmonic generation in lipid bilayers

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Keywords: Second harmonic generation, Optogenetics, Giant unilamellar vesicles

Unravelling the immense complexity of the human brain requires the ability to selectively interfere and record neural activity. 'Optogenetics' describes a variety of techniques for specifically controlling neural activity with light, using light sensitive membrane proteins (opsins).[1] Given the significant advantages of nonlinear optics, activating opsins by two-photon absorbance is already an emerging field.[2] Activity read-out by means of membrane potential sensing still relies on voltage sensitive fluorescent probes or microelectrode recording. However, it has been proven that retinal analogues can serve as voltage sensing probes by means of second harmonic generation (SHG), when inserted into the cell membrane.[3] Since opsins use this retinal chromophore as their photoswitch, we are investigating the potential of opsins to act as voltage reporters in order to obtain an all optical method for modulating cellular activity and read-out. Giant unilamellar vesicles as well as living cells can be used to test this hypothesis.

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Particle raft as interfacial armour: effects of particle mobility and polydispersity

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Keywords: interface, particles, coalescence
Main Topic: Adsorption and interfacial dynamics

We experimentally probe the robustness of particle rafts against drop impacts. We form at the air/water interface a controlled dense monolayer of hundred micron hydrophobic particles [1]. When a water drop impacts onto these rafts, two scenarii depending on the droplet velocity can occur: "coalescence" of the liquid droplet with the liquid underneath, or "non-coalescence" due to the particle protection. For comparison, we performed similar experiments after freezing the particles at the interface replacing water by an agarose gel. Similarly, we observe sharp transitions between coalescence/ non-coalescence corresponding to threshold velocities.
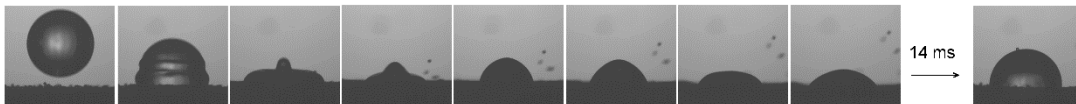
Non-coalescence of a drop (diameter of 2.3 mm) at 0.49 m/s on a raft of particles (monodisperse, diameter of 109 µm) at air/water interface. 2 ms separates consecutive images except mentioned otherwise.

Despite these similarities, the effect of particle size in both situations is drastically different. For rafts on water, the bigger the particle, the greater the threshold velocity and so the armour robustness. For particle rafts on gels, the larger the particles, the smaller the velocity threshold and so the weaker the armour. Two models are derived for monodisperse rafts. If the particles lay on water, they are mobile and during the impact process a hole "free of particles" opens into the raft which brings into contact the drop and the underneath liquid [2]. For particles on gels, the particles are immobile and coalescence occurs only if the water drop flows through the particle monolayer which constitutes a porous layer. The smaller the pores (and therefore the particles), the stronger the required pressure and thus, the greater the velocity threshold.

Observations made on bidisperse rafts show that the above mentioned sharp transitions are replaced by the coexistence of both coalescence and non-coalescence events for velocities ranging between the thresholds obtained separately with only the small, and only the large particles, respectively. This behavior is attributed to the local character of the drop impact probing. In contrast to other mechanical forcings such as compression or bending [3-4], no collective effects build up in the bidisperse rafts at the scale probed by drop impacts and sharp velocity thresholds disappear.

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Emulsion Stabilized by Alpha-Gel in Glycerol Surfactant System

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Alpha-gel is a kind of metastable crystal and has been utilized for cosmetic formulations in order to improve the long-term stability as well as tactile perception. The alpha-gel consists of the stacked bilayer in which the constituent molecules (generally a mixture of surfactant and long-chain alcohol) are arranged in the hexagonal sub-lattice. This molecular arrangement is a key factor to form the alpha-gel in solution and some ionic surfactants can empirically stabilize it, while the chemical structure of added surfactant is not well understood. Therefore, we investigate the alpha-gel formation using polyglycerol-type non-ionic surfactants with different structures of hydrophilic unit. In addition, the stability of oil-in-alpha-gel emulsion will be discussed in terms of the alpha-gel structure.

Two types of polyglycerol (PG) octadecanoic acid esters (PGFE) were used to prepare the alpha-gel: one has a narrow distribution of the linear PG chain (AE), and the other has the conventional PGs (QS). The HLB numbers of AE and QS are 12.9 and 11.0, respectively. Both the PGFEs showed the wide composition range of alpha-gel formation when mixed with cetylalcohol ($C_{16}OH$) or behenylalcohol ($C_{22}OH$) at room temperature. The repeat distance of the bilayer (d) and the intermolecular distance (d_{sub}) at 20wt% PGFE+$C_{22}OH$ (mole fraction of PGFE=0.25) was *ca.* 12 and 0.42 nm respectively, which were independent on the chemical structure of PGFE. In particular, these d_{sub} values were compatible with those in the other surfactant systems, and thus it was expected that the hydrophilic moiety of surfactant did not impact the alpha-gel formation. From the d value, the amount of water incorporated in the bilayers was estimated to be *ca.* 30% in the total amount, and 70% of water was stably trapped as a bulk phase into the alpha-gel network. In our experiments, the alpha-gel structures prepared by these two PGFEs were almost identical, even compatible with the polyoxyethylene octadecyl ether ($C_{18}EO_{15}$).

The alpha-gels formed by these PGFEs could stabilize emulsions where a mineral oil (MCT) or silicone oil was dispersed, and no phase separation was observed for more than one month even at 50 °C. The large amount of oil, ~40wt%, was allowed to retain in the alpha-gel network. The apparent viscosity of the emulsion increased with the oil content, suggesting the oil droplets were finely dispersed without dislocation and coalescence under shear flow. On the other hand, the emulsion formed by the $C_{18}EO_{15}$ alpha-gel shows less stability than the PGFE systems and the phase separation took place within one week at 50 °C. The alpha-gel structure in the $C_{18}EO_{15}$ system gradually disappeared with time in the presence of MCT, and simultaneously the emulsion was disrupted. This indicated that the stability of the alpha-gel structure would govern the emulsion stability and should be dependent on the kind of surfactant.

In conclusion, PGFE would be one of promising candidates to form a stable alpha-gel resulting in a stable emulsion, and this would be the reason why PGFE could be much insoluble in MCT rather than $C_{18}EO_{15}$.

POSTERS

EFFECT OF SURFACTANT AND WSP CONCENTRATION ON THE SIZE OF SULFUR NANOPARTICLES

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Sulfur finds extensive technological applications such as in production of sulfuric acid, plastics, enamels, antimicrobial agent, insecticide, fumigant, metal glass cements, in manufacture of dyes, phosphate fertilizers, gun-powder and in the vulcanization of rubber, etc [1]. So sulfur naoparticles would present higher efficacies such as removal of heavy metals, radical-scavenging, antimicrobial activity [2], antioxidant and antitumor activities [3]. It is used as a fungicide product in agriculture [4], also used in medicine, to obtain sulfur fertilizers and cosmetics industries, as well as in obtaining nano-composite lithium batteries [5]. In synthesis of sulfur nanowires with carbon to from hybrid materials with useful properties for gas sensor and catalytic applications [6].

Results of obtaining the sulfur nanoparticles, which can be used in agriculture as a fungicide treatment. Sulfur nanoparticles were obtained by modifying the surface of sulfur by various surfactants including cetyltriammoniumbromide (CTAB), sodium dodecylbenzene sulfanate (SDBS) and Triton X-100 (TX-100), water soluble polymer (WSP) sodium carboxymethylcellulose (NaCMC), polydi-metyldyalylammonichlorid (PDMDAAC) mineral mixtures (diatomite) and their compositions. The interfacial tension and critical concentration of surfactant at the water/air interface were measured by the method of Wilgemi, using surface tensiometer (DCAT-21, Date physics, Germany) at room temperature (28 ±0.5 0C).

The crystal structure of sulfur nanoparticles was characterized by X-ray diffraction (XRD) using Philips (230 v, 65 KVA) X-ray diffractometer with scanning rate of 0.0020/s in the 2θ range from 100 to 500. Particle size measurement was carried out by laser size analyzing (LSA) using Bettersize-2000 laser particle size analyzer. The shape of sulfur nanoparticles were observed with a scanning electron microscope (SEM). It is shown that the nanoparticles have a sulfur monoclinic β-form, and their average size is in the range 400-600 nm. The received products can be considered as perspective forms of application in agriculture.

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Keywords: Microemulsion, Pickering emulsion, interfacial tension, emulsion formation

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Impact study of contact angle boundary conditions for CFD simulation of two-phase flow generation in a T-junction

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Gas–liquid two-phase flows dominated by capillary forces occur in countless modern industrial applications. Some examples can be found in normal gravity (mixing process, chemical reactions, emulsion technology, materials synthesis, medical science, personal care products, etc), as well as in space-based systems (life-support systems for human exploration, thermal management systems, propulsion systems, chemical contactors, space bioreactors, etc). A better understanding and an improvement of two-phase flows generation techniques are thus mandatory for the optimal development of these technologies, both in normal and reduced-gravity environments. In the past, great efforts have been conducted to fulfil this goal, and several methods have been proposed, aiming to generate and control two-phase flows in a very accurate way. T-junction bubble generators have arisen as an efficient method providing trains of bubbles, immersed into a continuous liquid, with small dispersion in bubble size.

Very recently, the authors presented a 3D numerical study of the bubble generation process into a T-junction, obtained with the commercial Computational Fluid Dynamics (CFD) solver ANSYS Fluent v15.0.7 [1]. In this study, numerical simulations were compared with experimental data reproducing the same conditions. Numerical data agreed qualitatively but not always quantitatively, with experimental results. Numerical results were found to be very sensitive to the gas-liquid-wall contact angle boundary conditions. Consequently, CFD and experimental results never agreed simultaneously for time scale results (bubble generation frequency) and properties of bubbles detachment (bubble volume and velocity), and the real impact of the value of the gas-liquid-wall contact angle remained an open question.

The study presented here aims to tackle this issue, by explicitly discussing and quantifying the importance of the value of the gas-liquid-wall contact angle. New numerical data is provided and compared with experimental results. A significant better agreement between CFD and experimental results is found (in bubble generation frequency, volume and velocity), and the contact angle is confirmed to be a key parameter in these simulations.

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Keywords: Two-phase flow CFD, T-junction, contact angle

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The study of impacting drops spreading over porous media has received little attention compared to similar studies on impermeable surfaces, although such event is more commonplace and often plays an important role in several processes [1]. In our droplet impact experiments on porous stones, over a specific impact speed range, we see the release of high speed singular jets (Figure 1). The release of these singular jets was previously reported only during impact on Superhydrophobic surfaces and proposed to be related to the collapse of the air cavity inside the droplet [2]. We see two different regimes for the jetting mechanism on porous surfaces. In the low speed regime (Vi<0.65 m/s) it is seen that similar to the impermeable Superhydrophobic surfaces, jetting is mainly due to the collapse of the cavity during the receding phase of the droplet (Figure 1a). However, by increasing the impact velocity, jetting can be attributed mostly to the pinning of the contact line with the porous surface (Figure 1b). In Figure 2, the velocity of the ejected jet at different impact velocities for different porous and non-porous surfaces is given. For all the porous surfaces, the highest jet velocity occurs at low impact velocities. The jet velocity decreases with increasing impact velocity. As it can be seen in Figure 2, a big difference in the jetting behaviour on porous and non-porous surfaces exists. This observation suggests the effect of a partial air layer formed under the droplet on porous surfaces which results in less energy dissipation during droplet impact. To have better understanding about this hypothesis, different experiments are ongoing to characterize the porous surface parameters (pore-size, surface energy and roughness) and their effect on jetting phenomenon.
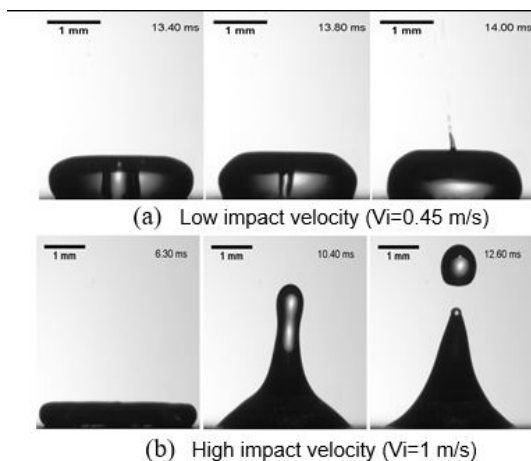
Figure 1. Fast camera snapshots of jetting mechanism at two different regimes, on Pietra Serena.
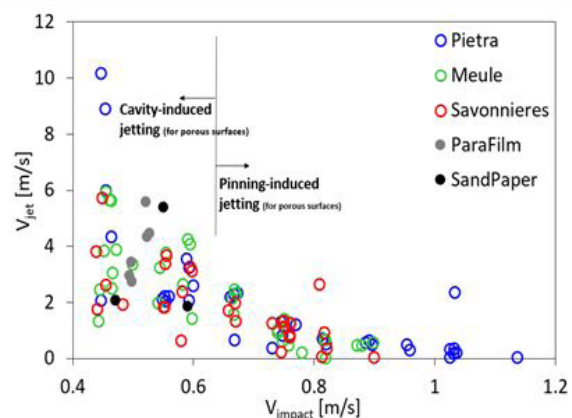
Figure 2. Velocity of the ejected jet at different impact velocities for different porous and non-porous surfaces.

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Keywords: Droplet Impact, Porous Materials, Jetting

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EXPERIMENTAL STUDY OF A BUBBLE FLOW OF AN AIR-LIFT UNDER VACUUM

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The air-lift column is a bubble column in which a partition has been introduced to channel the flow of the liquid and gaseous phases between several compartments of the column. The injection of air into one of the compartments makes it possible to modify the apparent density and the expansion of the diphasic fluid, causing the liquid phase to initially move [1]. The vacuum air-lift column, which is the subject of the present study, is based on the principle of air-lift and flotation, all under depression [3]. This air-lift column process was patented in 2007 by INSA Lyon and IFREMER. The experimental study of its hydrodynamics is one of the axes currently being explored in order to optimize its design and operation. The gas-liquid flows in these columns are intrinsically unstable and the dynamics of such flows influence the mixing and mass transfer performance of the bubble columns. Knowing the size of the bubbles and the void fraction is crucial for determining the gas-liquid interfacial air and therefore the mass transfer [2]. The aim of the study presented in this manuscript is to determine the phase-indicating functions (void fraction, interface velocity and bubble size) of the gas-liquid flow. The experimental analysis is carried out using a two-phase instrumentation constituted by a bi-prob optical-fiber. The use of experimental techniques has led to a better understanding of the hydrodynamics of the diphasic flow. The optical fiber bi-probe placed between two column flanges made it possible to have a complete mapping of the flow of the dispersed phase. The use of a mass flow meter and an ultrasonic flow meter, in different flow configurations, allowed data on the operation of the column. The hydrodynamic analysis of the column showed that the liquid flow rate in the air-lift column is directly proportional to the air flow rate injected over the air flow range from 2 to 30 l / min. On the other hand, for air flows above 30 l / min, an inverse phenomenon on the liquid flow rate is observed. To analyze the hydrodynamics of the dispersed phase using the optical bi-probe, a sample of 10,000 bubbles was determined.

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Keywords: bubbles velocity, void fraction, optical probes.

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ELECTRICAL CHARGING OF BOUNCING DROPLETS

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Droplets of water bouncing on superhydrophobic surfaces get an electrical charge

because of preferential adsorption of hydroxide ions at the interface [1].

Here we present the influence of the plate material, the superhydrophobic coating and the

initial charge of the drop on its equilibrium electric charge.

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Keywords: drop, electric charge

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DRAINAGE AND RUPTURE DYNAMICS OF EGG WHITE ALBUMEN PENDANT BUBBLES

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Proteins are biomacromolecules with hydrophilic and hydrophobic residues. They adsorb at interfaces and form multilayer structures. Typical examples of proteins forming thin film structures are egg white foams in food and surfactant proteins that prevent alveolar collapse. Similar to molecular surfactants such as detergents, proteins can form stable bubbles that survive for as long as there is enough water content in the thin film. In our work, drainage rate and surface tension are shown to greatly influence the stability of egg white albumen (EWA) protein pendant. Using the Young-Laplace equation, the Laplace pressure allows us to determine the surface tension of bubble thin films. We report our findings on not only the stability, but also the rupture of EWA thin films upon bubble failure. Equipped with a high speed camera, we capture bubble rupture videos at 30,000 frames per second. These videos provide information on the shockwaves resulting from film rupture and the rate of rupture propagation. The current literature on protein bubbles is mainly focused on foams, which makes a study on individual bubbles not only unique, but also important for providing information on the behavior of protein thin films in absence of a bulk layer of host fluid.

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EFFECT OF PARTICLE SIZE AND SURFACE HYDROPHOBICITY ON SELF-PINNING BEHAVIOR OF NANOFLUID DROPLETS

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When a nanofluid droplet dries out on homogeneous surfaces, a ring-like deposit of particles develops at the edge of the droplet. This phenomenon, known as the coffee ring effect, usually occurs whenever drops containing nonvolatile solutes evaporate on a solid surface. The evaporation process of a nanofluid droplet on homogeneous surfaces generally comprises: (1) the constant contact radius mode, (2) the constant contact angle mode, (3) the mixed mode, and (4) the second pinning mode [Lin et al., 2015]. The self-pinning concentration is defined as solute concentration when nanoparticles start to pin at the edge of the droplet. That happens to be in the beginning of the last pinned (or second pinning) mode in the evaproation process. The self- pinning concentration increases along with the surface hydrophobicity, which can be identified by the receding contact angle. It is interesting to find out that the self-pinning concentration is linearly dependent on the receding contact angle for a fixed nanoparticle size (silica nanoparticles of 400 nm in diameter) [Lin et al., 2015]. In addition, two more silica nanoparticles with 760 and 1000 nm in diameter are used to prepare the nanofluids. The selfpinning concentration decreases with an increase in particle size. For larger particles (such as, 760 and 1000 nm in diameter), the linear relationship between the self-pinning concentration and the receding contact angle of surfaces still remains intact but shifts downward.

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Keywords: hydrophobicity, coffee ring effect, evaporation

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EXPERIMENTAL DETERMINATION OF THE AMBIENT PRESSURE THROUGH THE RESONANCE FREQUENCY OF BUBBLES IMMERSED IN A GEL

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Abnormally high pressures at different points of the vascular system, such as inside the heart, the pulmonary artery or the portal vein, are associated with many vascular diseases. For this reason, physicians need to measure the pressure at these specific points in order to help diagnosis or to monitor the evolution of the patient's condition. Nowadays, these pressure measurements are performed invasively by means of catheterization, which presents several shortcomings. Thus, physicians would greatly benefit from the existence of a non-invasive alternative to acquire pressure measurements. Ultrasound Contrast Agents (UCA's), microbubbles injected into the blood stream to aid ultrasonic imaging, offer the possibility of obtaining the blood pressure at localized points of the circulatory system in a non-invasive way.

This is based on the fact that, when being insonated with an acoustic pulse, the amplitude of the bubble oscillations peaks at a certain frequency (resonance frequency), which value depends on the bubble radius and the surrounding pressure. Given that the gas volume inside the bubble remains constant with pressure variations and that its radius (R_0) it's known at some controlled conditions, where the pressure (P_0) and the resonance frequency of the bubble (ω_0) have been characterised, it is possible to measure the pressure variations on the bubble surroundings by detecting the new resonance frequency . $\omega_1 = \omega_0 (1 + \Delta P/P0)$

In order to experimentally prove the feasibility of the technique, bubbles immersed in gelatin are insonated with a chirp (a pressure pulse that covers a range of frequencies that includes the resonance one) at different surrounding pressures, and their radius evolution with time is obtained by processing the high-speed videos synchronously recorded with the chirp emission. Subsequently, wavelet analysis is performed on the bubbles radius time evolution to determine the main frequency at which they oscillate. We then compare these experimental results with theory.
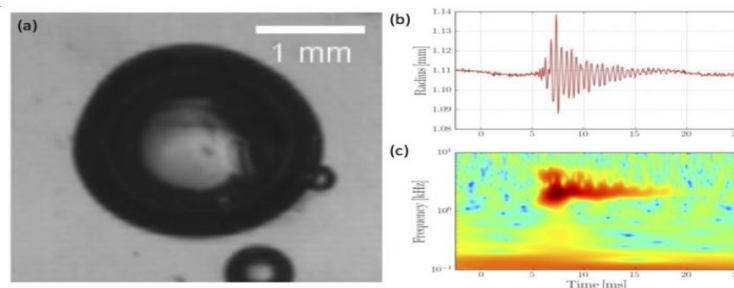
a) Snapshot of the high-speed movie showing a bubble immersed in gelatin. (b) Time evolution of the radius of this
bubble under chirp insonation. (c) Wavelet spectrum of the same signal.

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FOAM ACOUSTICS: FOCUS ON THE VIBRATIONS AT THE BUBBLE SCALE

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The acoustic properties of liquid foams have been investigated in details recently. Although the acoustic wavelength is 10 to 103 larger than the bubble size, the acoustic velocity and attenuation depend drastically on the bubble size [1]. The modeling invokes the role of the vibration of the liquid interfaces of the foam: the relevant length scale is not the acoustic wavelength in the foam, but the wavelength of the vibration wave on the liquid interfaces at the forcing frequency.

In this presentation, we investigate the vibrations of the liquid skeleton of the foam, whose constitutive elements are isolated one by one. We measure the dispersion relation and the attenuation of a transverse wave on each of these elements. We study an isolated soap film submitted to a transverse vibration (bending wave): we measure the phase velocity and the attenuation of the wave. A theoretical modeling identifies the relevant parameters that contribute to the inertial and elastic response of the vibrating films, and to the dissipative effects [2]. When three soap films meet at a Plateau border junction, the inertia of the liquid in the channel must be taken into account, as well as the tensile surface forces exerted by the soap films on the Plateau border. Does the Plateau border vibrate like the (free) border of a liquid membrane, or does it behave as an inertial liquid string? We show that the answer is in between: two regimes are identified as a function of the frequency [3].

Both experiments on soap film and Plateau border show the essential role of the surrounding air, especially in the dissipation processes [4]. This is consistent with our recent observations at the foam scale where the acoustic propagation in foams depends on the nature of the gas, and we try to make the link between the approaches at these two different scales.

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Keywords: Soap film, Transverse wave, Foam acoustics

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GAS WELL DELIQUIFICATION FOAMERS FOR HIGH TEMPERATURE AND HIGH SALINITY CONDITIONS

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As gas wells age, they experience a drop in production due to decreasing pressure from the accumulation of water or condensate inside the well. This decrease of the production negatively impacts the economy of the well for oil producers. Currently there are several different techniques to unload the water including mechanical approaches such as velocity string, wellhead compression, and gas lift, as well as chemical treatments involving several classes of surfactants used to foam the well fluid.

Today's gas wells have challenging conditions (high temperature, salinity and condensate) that limits the performance of typical foamers chemistries. Betaine foamers can exhibit performance up to 170°C, higher than other typically used foamers. The Alpha Olefin Sulfonates (AOS) can perform at higher temperatures; however, their poor salt tolerance makes them unsuitable for usage in wells with high salinity produced water. We present today the superior performance of our new foamer, Petrostep B-1235 at high temperature and high salinity conditions.

The foamers performance were measured by using a standard dynamic foam unloading test. Alkyl Ether Sulfates (AES) and AOS were screened as benchmarks. AES have a poor temperature tolerance and thus showed no foaming performance above 110°C. AOS exhibited better results at high temperature but showed poor performance in 12.5% and 25% Total Dissolved Solid (TDS). An increasing quantity of condensate up to 20% reduced even more their performance. On the other hand, Petrostep B-1235 showed stability up to 220°C and maintains performance with in high TDS brines

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Keywords: Gas well, foam, surfactant

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LASER MANIPULATOR FOR LIQUID DROPLETS: AUTOMATED DOSING AND TRANSPORT

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N.A. Ivanova

The digital microfluidics relied on the manipulation of tiny droplets is a promising instrument for conducting of biological and chemical assays in lab on chips (Teh et al, 2008). Recently, we reported (Bezuglyi and Ivanova, 2007) a new method for the droplet generation in thin layers of binary liquid mixtures using solutocapillary forces controlled by heat action of a laser beam. Here we demonstrate a prototype of the microfluidic laser manipulator, which enable to perform of various manipulations, including dosing and transportation of multiple sessile droplets in the open channels using two semiconductor lasers.
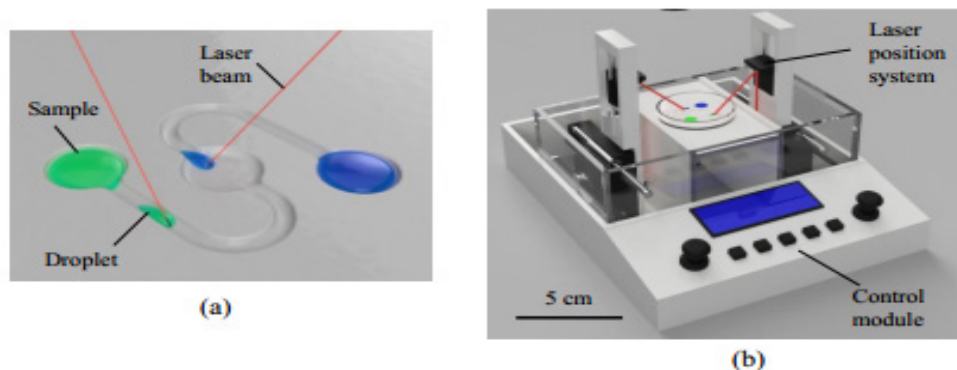
Figure 1: (a) The microfluidic platform, (b) the general view of the microfluidic laser manipulator.

Fig. 1(a) shows a schematic view of the open microfluidic platform, which is created by the heat press forming of PMMA sheets. Two laser beams generate the sample droplets from reservoirs and transported them into the reactor through the channels. Fig. 1(b) shows the general view of the microfluidic laser manipulator consisting of two lasers, which are moved in x-y plane. Depending on the experimentalist demand, the microfluidics procedure is realized on either the software level or manually using joysticks.

The proposed microfluidic laser manipulator is a non-invasive and highly precise instrument for actuation of liquid droplets on microscale and can be used for both scientific investigations and routine laboratory analysis.

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Keywords: droplet microfluidics, microfluidic platforms, solutocapillary convection

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LASER-INDUCED THERMOCAPILLARY OSCILLATIONS IN LIQUID-LIQUID SYSTEMS

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Thermocapillary convective instabilities in two-layer systems confined two rigid walls is of great importance in nature and industrial applications (Nepomnyashchy et al, 2012). Here we demonstrate a new kind of oscillatory instability arising in the two-layer systems with a free top layer under a laser heating of the liquid-liquid interface.
For analysis of the processes in the system,
the time evolution of the diameter of the interference fringe (PTC signal) formed on a remote screen by a partially reflected laser beam from the deformed free liquid interface was measured.
Benzyl alcohol absorbing the laser beam and transparent silicon oils (5, 10 and 20 cS) were used as the bottom and top layers, respectively. The Thickness of the botteom layer was h_b =2 mm, but the thickness of the top layer (h_t) was varied from 0.3 to 1mm. Three modes of the thermocapillaryconvection depending on the thickness ratio $H=h_t/h_b$ were identified: (i) the steady state thermocapillary rupture of the top layer - H <0.3; (ii) the steady state thermocapillary depression H>0.4; and (iii) the decaying oscillations - H Laying in between 0.3 to 0.4, Fig. 1a.
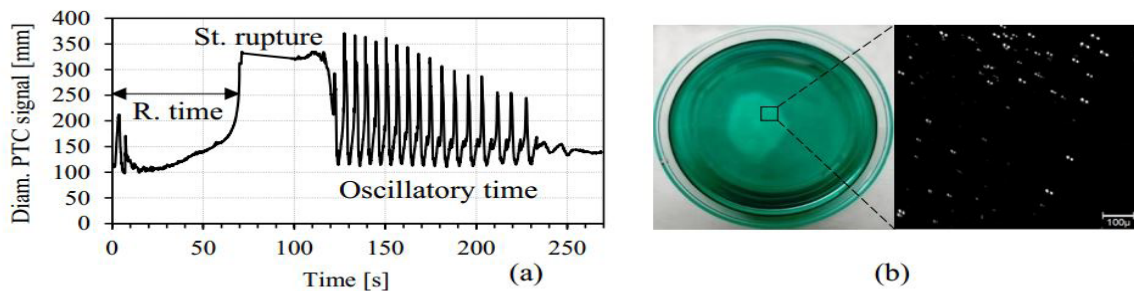
Figure 1: (a) Time evolution of the PTC signal in the oscillatory mode. (b) A top view image of the two-layer system with the bubble cluster and the micrograph of bubbles.

We found that in the decaying oscillations mode a decreasing H and an increasing viscosity of the top layer leads to the increase in the oscillatory time and a decrease in the amplitude and the period of the PTC signal oscillations. We have assume that the mechanism behind the oscillations itself is the competition between thermocapillary and solutocapillary forces, which act in opposite directions. The decaying of the oscillations is caused by an apparence of bubbles (~50 μm in diameter) at the interface in the laser spot area, fig. 1(b), hich scatter the laser radiation and, therefore, prevent the absorption of the light energy. To clarify the bubbles formation mechanism more experimental investigations to be done.

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Keywords: liquid-liquid interface, thermocapillary convection, bubbles

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GROWING DROP EXPERIMENTS WITH SURFACTANT SOLUTIONS

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Measurements of dynamic interfacial tensions γ (t) are the easiest experiments to get access to the adsorption mechanism of surfactants. There are various methods for measuring γ (t), however, most versatile are methods based on single drops and bubbles [1]. These methods allow to accurately determine the changes in interfacial tension as well as to record the response of interfacial layers to external perturbations in order to obtain the dilational interfacial visco-elasticity. In this contribution, we discuss the application of drop profile analysis as well as capillary pressure tensiometry to aqueous solutions at the interface to air, alkanes and alkane vapor. Both methods are used in different experimental modes and it is shown that oscillating drops as well as growing drops provide interesting features of the interfacial dynamics [2, 3]. It is demonstrated, however, that complex simulations are required to get access to the details of the adsorption process coupled with liquid flow pattern [4]. A simpler access to understanding the dynamic data is possible via simplified models, such as the one given in [5].

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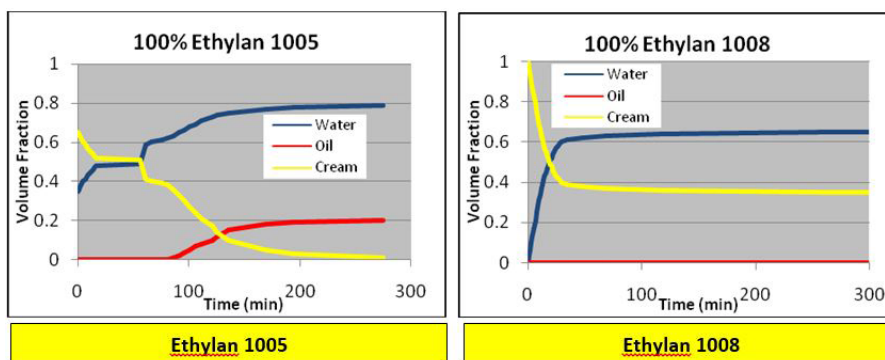# Catastrophic Phase Inversion to Produce Stable Emulsions at Low Energy

T. D. Karapantsios,

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In the present emulsions, paraffin oil is the organic phase and Millipore water is the aqueous phase. The non-ionic surfactants Ethylan 1005 and Ethylan 1008, either alone or mixed at different proportions, are used as emulsifiers/stabilizers. These two surfactants are produced by a special ethoxylation technique of the narrow range C10 Guerbet alcohol, having 5 or 8 moles of ethylenoxides per mole of alcohol, respectively. They are completely odorless, easily biodegradable and appeared in the market in the last ten years aiming to replace alkylphenyl ethoxylated surfactants. The use of the later in products such as detergents has been prohibited in Europe, as they are not easily degraded during waste treatment and remain in the environment forming toxic intermediates which can have estrogenic impact at certain environmental concentrations.

The emulsions are prepared by the catastrophic phase inversion method which is capable of creating quite stable emulsions at low energy (stirring) conditions. Emulsification takes place inside a glass beaker containing initially the paraffin oil/surfactant mixture to which the aqueous phase is gradually dripped under mild (300 rpm) mechanical stirring with a Rushton turbine. Emulsion stability is studied by two different methods. The first method refers to optically registering the separation of phases (water/oil/cream) inside a 100ml volumetric cylinder to which the emulsion is poured right after its preparation. The second method has to do with the evaluation of the emulsion droplet size distribution from the analysis of high resolution images taken by a microscope.

It is interesting and counter-intuitive that although Ethylan 1005 droplets are much smaller than Ethylan 1008 droplets, the Ethylan 1005 emulsions are less stable. This might be attributed to the appreciably smaller stereochemical impact of Ethylan's 1005 smaller polyethylenoxidic chain (5EO instead of 8EO in Ethylan 1008). Work is underway to clarify this issue.

Phases (water/oil/cream) separation versus time after the completion of emulsification by Catastropic Phase Inversion with Ethylan 1005 & Ethylan 1008. The phases separate fully in 2.5h (275min) in the Ethylan 1005 emulsion while separation is not completed in the Ethylan 1008 emulsion.

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Keywords: Phase inversion, stability, non-ionic surfactants

INFLUENCE OF WAKE PRESENCE ON BUBBLE ACCELERATION AND LOCAL VELOCITIES

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A15

1 Bubble & drop formation, motion, interactions

The description of bubbles motion is a major challenge in a wide range of application from froth flotation to biotechnology and chemical engineering. Due to a complex nature of bubble motion there does not yet exist any general theory describing the motion of bubbles at high Reynolds numbers. According to Frumkin-Levich theory the viscous drag exerted by continuous medium on the rising bubble surface causes uneven distribution of the surfactant molecules adsorbed. The uneven adsorption coverage induces the surface tension gradient over the bubble surface that diminishes the bubble surface fluidity and as a consequence, the bubble velocity is lowered. The process is generally known as the Marangoni effect due to formation of Dynamic Adsorption Layer (DAL) formation.

In this paper I propose an innovative method, which allows visualizing the processes occurring in the wake of the moving bubble. In the experiments I used the mixture of CTAB as the surfactant and dye (methylene blue) that allows to study the evolution of wake, it size and shape.

The results confirmed that the size of wake increases gradually with the CTAB solution concentration and with the distance from the capillary. It means that the hydrodynamic drag caused by the wake should also be considered during the analysis of free rising bubble experiments. I also found that the zig-zag path of the motion is strictly connected with the turbulences in the wake region. In high Reynolds number flows such turbulences are caused by flow separation. I believe that it ultimately confirm the assumptions of the Frumkin-Levich theory. Flow separation can occur exclusively as the result of boundary layer immobilization. However, in contrary to the classical understanding of the DAL theory, One can hypothesize that we observe the periodic (cyclic) formation and detachment of the Dynamic Adsorption Layer. The process occurs periodically during bubble a deceleration and in the motion with the zig-zag or helical path.

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Keywords: Bubble motion, local velocities, acceleration, bubble wake

STABILITY OF WHEY PROTEIN WET FOAMS GENERATED IN DOUBLE-SY-RINGE DEVICE

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Application of foams is essential in various natural, industrial or scientific processes. However, in the most of them synthetic surfactants are used that have negative environmental impact. Therefore, we constantly search for new, non-toxic and biodegradable replacement of synthetic foaming agents. Main focus of the research is placed on bio-surfactants, which in much easier way could be removed or biodegraded in the sewage treatment plants.

In this paper we studied the foaming properties of two various whey proteins. The surface activity of proteins mixtures was improved by addition of trace concentrations of some synthetic (but safe/non-toxic) ionic surfactants. Selected polysaccharides were also incorporated into the mixtures to increase their bulk viscosities. Our specific objective was to find correlations between surface activity and foaming properties. Foamability and foam stability of mixtures were studied in the double syringe device where foams were generated due to the series of ten compression and expansion cycles [1,2]. That device allowing for the control of initial gas volume fraction was used previously to study foaming properties of various synthetic surfactants. To the best of our knowledge our work presents the first attempt to use it for foamability studies of bio-surfactants mixtures. Additional advantage of the method is an easy transfer of formed foam into other measuring devices, like rotational rheometer or various kinds of optical microscopy.

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Keywords: foam stability, whey protein, colloidal particle, particle hydrophobization, dual syringe foaming device, poly-saccharides

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MICROSTREAMING INDUCED BY NON-SPHERICAL BUBBLE OSCILLATIONS

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Known as a promising tool for transfection, ultrasonically excited bubbles can be used to increase cell membrane permeability and promote the transfer of molecules into cells. However, the mechanisms involved during this process – sonoporation – are neither well understood, nor well controlled. Under the action of an acoustic field, bubbles present radial oscillations generating flows around the bubble (microstreaming) [1, 2], thus producing shear stresses in the liquid which may be responsible for an increase of the membrane permeability [3]. Recent studies show the possibility to tune the flow shear stress from shape oscillation modes of bubbles [4, 5]. Nevertheless, these studies deal with bubbles attached to a wall, thus implying that flows are affected by the presence of the rigid surface.

In the current work, we particularly focus on the properties of the microstreaming generated by non-spherical oscillations of a "free" bubble. Air bubbles (R ~ 50 μm) are nucleated by a focused laser pulse and trapped in an acoustic field at a frequency of fa = 31.20 kHz. Bubbles are insonified by a slowly varying (fm   fa) amplitude-modulated signal that allows generating the shape modes periodically [6]. Different shape oscillation modes are obtained depending on the bubble size and by adjusting the acoustic pressure. Microstreaming patterns are captured by seeding the vicinity of the bubble by micro-particles and visualized by backlighting. Additionally, velocity fields are obtained with fluorescent particles imaging velocimetry (PIV). Influence of the different shape oscillation modes on the microstreaming is discussed.

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Keywords: Microstreaming, shape oscillation mode

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DYNAMICS OF CONTACT LINE PINNING AND DEPINNING DURING DROPLET EVAPORATION ON HYDROPHYLIC MICRO-PILLAR ARRAYS

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Droplet evaporation phenomena have been widely investigated and our understanding is constantly advancing. In particular, the study of dynamics of contact line pinning/depinning during droplet evaporation on porous surfaces is mainly limited to experimental analysis and with little work on hydrophilic surfaces. In this study, we focus on the simulation of evaporating droplets deposited on an array of micro-pillars using the lattice Boltzmann method (described in [1,2]). Upon deposition, due to the effect of capillary action, a part of the droplet penetrates into the inter-pillar space while the remaining droplet remains pinned. A first stage of evaporation is continuous until the droplet undergoes a series of stick-slip events, showing alternatively constant contact radius and constant contact angle modes as described next. During evaporation, the contact angle is initially reduced while the contact radius remains constant as the contact line is pinned. When the decreased contact angle reaches a critical value, the pinned contact line is released. This pinned-depinned behavior is repeated until the liquid lying above of pillars is fully evaporated. By computing the drop Gibbs free energy, and including viscous dissipation due to internal droplet flow, we find that the mechanism that causes the unpinning of the contact line results from an excess Gibbs free energy. We also show, using our simulations, that the capillary distance between pillars plays an important role in the magnitude of the critical contact angle and the maximum excess free energy.
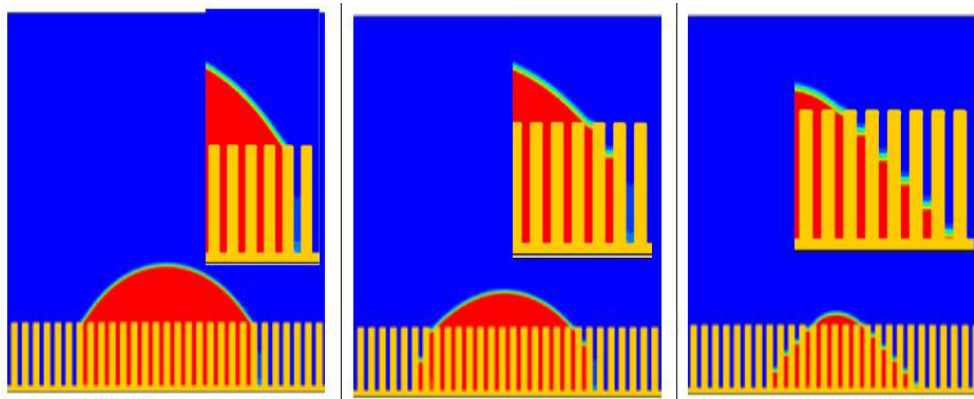
Figure 1: Snapshots of different stages of liquid drop evaporating on hydrophilic micro-pillar arrays.

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Influence of surfactants and gas properties for the preparation of microbubbles by membranes

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A19

Microbubbles with potential applications in areas such as the food, cosmetics, biomedical and chemical industries continue to be a subject of interest for many researchers. The development of processes to produce microbubbles which provide a high degree of size control, compositions, stability and uniformity is necessary1.

The aim of this study is to investigate a method for generating uniformly sized and stable microbubbles with a high yield using a membrane. Especially, the effect of various surfactants and gas on microbubbles formation, size and stability is investigated.

Microbubbles are generated using a Shirasu porous glass (SPG) membrane with a narrow pore size distribution. A gaseous phase is forced through the membrane pores into an aqueous phase and consequently size controlled microbubbles are generated at the interface between the membrane surface and aqueous phase under suitable process conditions. Microbubbles are formed with different surfactants and air or perfluoropropane (C3F8).

Optical microscopy (Leica DMLM) is used for sizing and counting microbubbles. To evaluate their stability, the microbubbles size distribution is measured as a function of time via optical microscopy. In addition, dynamic bubble profile analysis tensiometry (DSA10 Krüss) is used for determination of the equilibrium interfacial tension.

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Keywords: Microbubbles, Membrane process, Surfactants

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STUDY OF CHITOSAN-ALGINATE MICROCAPSULES WITH ENCAPSULATED HYDROPHILIC DRUGS

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Many papers are devoted to the development of delivery systems to encapsulate, protect and release lipophilic substituents. The emulsion technology is suitable for the design and fabrication of microcapsules, however, for hydrophilic substances O/W emulsions are not appropriate. For this purpose, is more suitable to use double emulsions, i.e., droplets of one fluid encapsulated inside droplets of another fluid. By the double emulsion method, the core droplets can be loaded with many substances to achieve various functions such as the encapsulation of nutrients, drugs, antibodies etc. [1].

This study aims at developing chitosan-alginate microcapsules as delivery carriers for hydrophilic substances. Lipase from Mucormiehei was used as the protein to be encapsulated by the double emulsion technique. In order to establish the optimal conditions for the capsule formation, different formulations were studied by changing the concentrations and pH of Chitosan, and the concentration of Xanthan, Chitosan and Sodium Alginate while analyzing their effect on the size, surface change and association efficiency of Lipase.

Some of the formulation parameters were determined in a previous work [2] and were used in this protein encapsulation study. The microcapsule formulation was evaluated by the encapsulation efficiency, loading capacity, and release profile. In the first step, protein was loaded into oil with surfactant for obtainment an O/W primary emulsion. In the second step, 3 ml of the primary O/W emulsions were then re-emulsified in 25 ml of 0.5%w/v, Chitosan solution at 3000 rpm for 1 min at room temperature. 5 ml of the secondary emulsion, produced by use of a Chitosan solution, then were incubated into 25 ml of 3% sodium alginate solution during 2 h., and then by injection was passed through a 1% solution of CaCl2, and washed by water and finally filtrated.

For detecting the lipase activity we used fluorescein dibutyrate and measurements were performed with a UV-spectrophotometer [3]. The EE and LC of the resulted enzyme microcapsules reached 83.5% and 15%. After 2 h incubation in PBS solution the total release reached 70%.

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Keywords: Capsules, double emulsions, chitosan

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FREEZING AND MELTING OF WATER DROPLETS ON HEATED SUPERHYDROPHOBIC POROUS SURFACES

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Understanding and controlling ice formation from supercooled water on surfaces is a problem of fundamental interest and general utility. Several recent works are found in the literature1-3. However, despite the extensive progress, the full determination of the freezing and melting mechanisms of a droplet on super repellent surfaces still remains a challenge. In the present study we experimentally investigated the freezing and melting processes of water droplets on super-hydrophobic porous surfaces at two different temperatures (23°C and 80°C). The cooling and the subsequent spontaneous freeze of droplets was obtained by an abrupt reduction in the pressure inside the chamber. The freezing process that appears to be initiated by homogeneous nucleation near the gas-liquid interface is comparatively studied in a first part of this work. In a second time, focusing on the temporal evolution of freezed droplets we discuss the role played by the substrate temperature. The melting process observed only on heated substrate appears to follow three sequential stages. (i) formation of a frost continuous layer, resulting from liquid-ice coexistence inside the freezed drop; (ii) multiples spindly frost crystals appear covering all the drop surface; (iii) collapse of the frost crystal with melting and a liquid water drop restitution. The evaporation process of this "new" drop is then analysed.

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Keywords: Droplet, Heated surface, Freezing, Melting

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DYNAMICS OF A TRAIN OF BUBBLES IN A MICROCHANNEL

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Nowadays, microfluidic devices are increasingly used for fundamental and exploratory studies in chemistry and biology. Recently, bubble dissolution in micro-channels has become of great interests for its application in CO2 sequestration or reactant dissolution.

Given that the flow structure around the bubbles strongly influence the mass transfer (see fig.1), we present numerical solutions of the Navier-Stokes equations for a train of bubbles in a microchannel. We consider a volume containing one bubble with pseudo-periodic boundary conditions in the inlet and outlet of the channel to accommodate the pressure drop along the channel. Stress-free boundary conditions are imposed at the surface of the bubble in the case of clean bubble, and rigid boundary conditions in the limit of infinite Marangoni effect due to the presence of the appropriate surfactants [1]. The deformability of the bubble is also considered.

Fig.1.

The migration force $\mathcal{L}$ must balance the external force at the equilibrium position ε. If we consider the small Re number regime (Re = $\rho J d_h/\mu$, where ρ, J, d_h and μ are the density, mean velocity, hydraulic diameter and viscosity, respectively), the inertial migration force is proportional to the inertial force $\rho J^2 dh^2$. We observe in fig.2 that some equilibrium positions are stable and that the bubble moves with a velocity V/J. Analogous to the inertial migration force, the capillary migration force is proportional to the deformability of the bubble $\mu^2 J^2 d_h/\gamma$ (where γ is the surface tension) and the bubbles deform so that the migration force is always pointing toward the centre, fig.3. We explore a wide parametric range of Re and Ca numbers and obtain the influence on the migration force, velocity of the bubble and pressure drop as a function of both the size and the position of the bubble. We obtain stability diagram of the centred position in absence of external force as a function of the Ohnesorge number and the bubble size.

Fig.2. Migration force and velocity

Fig.3.   Bubble deformation

In this work, we have shown the dominant effect of migration forces on the equilibrium position of the train of bubble, which should definitely have a strong impact on any heat or mass transfer processes in such a system.

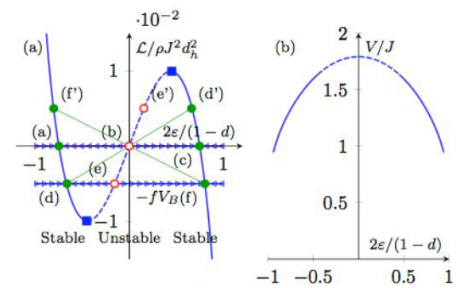[1]Mikaelian, D.; Haut B.; Scheid B. Microfluidics and Nanofluidics, 19(3), 523-545(2015)

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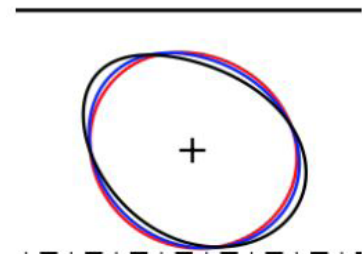e-mail: jriveror@ulb.ac.be

ADSORPTION OF TRICLOSAN AS MODEL SYSTEM FOR WASTE WATER TREATMENT BY THE MINERAL SORBENT DIATOMITE

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Triclosan is a common synthetic antimicrobial agent widely used in domestic and consumer care products such as toothpaste, mouthwash, soaps etc. Triclosan is additionally used as a stabilizing agent in many cosmetic and detergent products. Its widespread use lead to increased concentrations of Triclosan in wastewater to be removed in treatment plants and sewage water intakes.

Nowadays, one of the most promising technologies is the processing of natural raw materials, the utilization of wastes and attraction of ecologically friendly secondary products in economic recycling. At present, different sorbents are used for the treatment of industrial waste waters. Aluminosilicates like diatomite, kaolinite, bentonite and etc. are interesting to be studied as sorbents for the waste water treatment due to their folded structure which is reflected in high dispersity, hydrophilicity and good ion exchange properties. Moreover, they are low cost sorbent materials with easy accessible sources.

In this work, we studied the adsorption of Triclosan as model systems by the mineral sorbent diatomite. The Triclosan equilibrium concentration was measured spectrophotometrically, the morphology of the diatomite characterized using scanning electron microscopy and the amount of triclosan adsorbed at the diatomite was quantified by a mass balance. Adsorption isotherms were analyzed according to the linear/nonlinear form of Langmuir, Freundlich, Sips and Toth adsorption models, using the AMPL software. It is shown that the nonlinear Langmuir and Sips isotherm models provided suitable fitting results. No significant differences in the adsorption efficiency between the isotherms measured after 1, 2 and 3 days of adsorption were observed. The determined maximum adsorption capacity of diatomite towards Triclosan is q_s=140 mg/g. Averaged calculated values of ΔG are -9.9 and 9.6 kJ/mol for the Langmuir and Sips models, respectively. The negative sign of the values indicates a spontaneous, physical adsorption.

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Keywords: Triclosan, adsorption, diatomite

CAPILLARY PENETRATION INTO INCLINED CIRCULAR GLASS TUBES

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The spontaneous penetration of a wetting liquid into a vertical tube against the force of gravity and the imbibition of the same liquid into a horizontal tube (or channel) are both driven by capillary forces and described by the same fundamental equations. However, there have been few experimental studies of the transition from one orientation to the other. We report systematic measurements of capillary penetration of polydimethylsiloxane oils of viscosities 9.6, 19.2, and 48.0 mPas into glass capillary tubes. We first report the effect of tube radii R between 140 and 675 μm on the dynamics of spontaneous imbibition. We show that the data can be fitted using the exact numerical solution to the governing equations and that these are similar to fits using the analytical viscogravitational approximation. However, larger diameter tubes-show a rate of penetration slower than expected using an equilibrium contact angle and the known value of liquid viscosity. To account for the slowness, an increase in viscosity by a factor (η/ρ) (scaling) is needed. We show full agreement with theory requires the ratio Rh(similar to 0.1 or less, where κ-1 is the capillary length. In addition, we propose an experimental method that enables the determination of the dynamic contact angle during imbibition, which gives values that agree with the literature values. We then report -'measurements of dynamic penetration into the tubes of R = 190 and 650 μm for a range of inclination angles to the horizontal φ, from 5 to 90 degrees. We show that capillary penetration can still be fitted using the viscogravitational solution, rather than the Bosanquet solution which describes imbibition without gravity,, even for inclination angles as low as 10 degrees. Moreover, at these low angles; the effect of the tube radius is found to diminish and this appears to relate to an effective capillary length, κ-1(φ) =(γLV/ρg sin φ)1/2.

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Keywords: Capillarity, Bosanquet, Lucas, Washburn, viscogravitational, regime transition

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BREAKUP OF BUBBLES IN A TURBULENT FLOW: NUMBER OF DAUGHTER PARTICLES AND THEIR SIZE DISTRIBUTION

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The breakup of air bubbles in a turbulent flow of water is studied experimentally. Water flows from an array of coaxial nozzles, generating intensive turbulence, and then flows downward through an experimental cell. Bubbles (1.8 to 5 mm) are injected in the bottom part of the cell and rise towards region with more intensive turbulence, where they break. Bubbles are tracked by means of a high-speed camera. The velocity field in the cell is measured by PIV. The local dissipation rate is estimated using large-eddy PIV technique. Statistics of velocity difference is evaluated as well.

From recorded movies, time spent by bubbles in various zones without breaking is evaluated and number of breakups is counted, providing information about breakup frequency. Number of daughter bubbles is determined and their size distribution is established.

Mean number of daughter bubbles depends mostly on the breakup Weber number We (Weber number, in which the velocity scale is the mean quadratic velocity difference across bubble diameter). Breakups are observed for We exceeding 0.5, though they are rare at this low We. Till about We ≈ 2, most breakups are binary; then the mean number of daughters increases, but is also varying between breakup events.

The size distribution of daughters can be presented either in dependence on the breakup Weber number, or in dependence on the number of daughters issuing from breakups. The former distribution is well reproduced by convoluting the number of daughters for given We with the size distribution for given number of daughter particles. Comparison of the convoluted with the measured size distribution suggests that the daughter size distribution is essentially controlled by the number of daughter particles issuing from the breakup.

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Keywords: Bubble breakup, turbulent flow, size distribution

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APPLICATION OF 3D CLINOSTAT FOR EVALUATION OF EMULSION STABILITY

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Emulsion disruption can occur through four processes; creaming, flocculation, coalescence, and Ostwald ripening. Every emulsion goes toward phase separation at equilibrium via one of or multiple routes to achieve minimum interfacial area between water and oil. In spite of wide range of industrial applications, the theoretical understanding on the long-term stability of emulsion has not been well established. In addition, there are few investigations on these demulsification processes taking into consideration the creaming phenomenon, although it is considered to be a critical factor to disrupt practical emulsions with a large diameter (typically a few micrometers). Therefore, evaluation of the emulsion under zero- or micro-gravity should be significant to understand these complicated processes through emulsification and demulsification, and the motive and objective of our study is to investigate the gravitational effect on emulsion stability using a centrifugal and 3D clinostat in various oil/water/emulsifier systems. The 3D clinostat is often used for cytological and plant researches, while never used for any liquid systems. Therefore, our study would be the first challenge to investigate the emulsion stability under microgravity using a 3D clinostat.

The 3D clinostat and the centrifugal were used to set quasi-microgravity and hyper-gravity environments, respectively, ranging from 0.03G to 1900G. The present study investigated the water/silicone oil (Decamethylcyclopentasiloxane, D5) emulsions with two emulsifiers, a common surfactant (KF-6038, Shin-Etsu Chem. Co., Ltd) and AIM (Active Interfacial Modifier, Seiwa Kasei Co., Ltd.). AIM is able to inhibit coalescence of the emulsion which naturally occurs in the surfactant systems. In the both systems, increase in the gravitational force accelerates creaming of the emulsion, following the Stokes law, and interestingly not only creaming but growth of the emulsion droplet disappeared under microgravity. Therefore, the microgravity environment may give us a new insight of the emulsion stability and interaction between the droplets such as electrostatic force; we can independently evaluate coalescence and flocculation under microgravity by comparing between different emulsion systems. In our presentation, we will show further results on the emulsion stability as a function of the gravitational force and the deterioration kinetics of not only W/O-type but also O/W-type emulsions.

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AUTOMATIC SINGLE BUBBLE GENERATOR WITH ADSORPTION TIME CONTROL

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Control generation of a single bubble from a capillary orifice is desired in laboratory practice. Flotation experiments in single-bubble Halimond tube, determination of a bubble rising parameters, observations of the bubble collisions with various interfaces (study on stability of liquid films formed under dynamic conditions), etc. require controlling of a single bubble formation with adjustable frequency of detachment. Moreover, in experiments in solutions of surface active-substances (SAS), a precise control of the adsorption time at the detaching bubble would be beneficial for studies on kinetics of development of the dynamic adsorption layer (DAL) over the rising bubble surface.

We present principles and reliability tests of elaborated automatic, fully programmable single bubble generator, allowing precise control of bubbles formation in liquids in terms of detachment frequency and adsorption time, available for adsorption of the SAS molecules at surface of the motionless bubble. It is shown that, depending on the orifice diameters, bubbles of various sizes can be produces "on-demand" with outstanding reproducibility (see Figs 1A,B). It is showed, moreover, that automatic programmable "bubble trap", synchronized with the bubble detachment frequency, can be used for (i) control of the released bubble radius (coalescence of desired numbers of single bubbles – Fig. 1C) and (ii) precise adjustment of initial adsorption coverage over the detaching bubble surface suitable to study the influence of this parameter for development of DAL over the rising bubble interface.
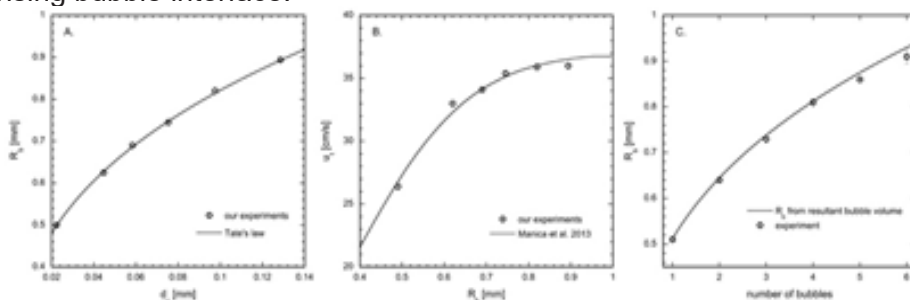
Fig. 1 Radius (A, C) and terminal velocities (B) of bubbles formed using our generator (points – experimental data, lines – theoretical predictions of: (A) Tate 1864, (B) Manica et al. 2013 and (C) bubble volume

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Keywords: bubble; capillary, pressure, adsorption

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INFLUENCE OF POLYMER-SURFACTANT COMPOSITIONS ADSORPTION ON PROCESS OF CLEARING OF OIL EMULSION FROM WATER AND SALTS

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Formation of oil emulsions leads to oil losses at its extraction, transportation and preparation for processing. Destruction of emulsions (deemulsifying) is one of the major processes of trade preparation of oil that is reached by use of various deemulgators.

One of the parameters which studying allows to give the prognosis to application of surfactants as deemulgators is the adsorption of two not mixing liquids on interfaces.

Study the colloid-chemical properties of Polyacrylonitrile derivatives compositions with surfactants have allowed to predict their application as deemulgators during oil clearing from water and salts. Results of research showed, that deemulsifier action of polymeric compositions substantially depends on the macromolecules conformation condition defined by a degree of polymer functional groups ionization [1]. Besides deemulgation depends also on surface activity of polyelectrolyte compositions with surfactants at the interface.

The values of surface activity of polyacrylonitrile derivatives compositions with sodium salts of oleic acid showed, that formation of a composition leads to increase in surface activity and reduction of standard free energy of polymers adsorption.

Increase of pH with growth of polymer concentration in a mix testifies about interaction between surfactant and polymer by hydrogen bonds formation that leads to change of the macromolecules adsorption parameters in mixes. As a result occurs the shielding of surfactant and polymer polar groups, that will lead to increasing of the macromolecules hydrophobicity and strengthening of intra-and intermacromolecular hydrophobic interactions in compositions. Reduction of the standard free energy of macromolecules adsorption during the complex formation testifies about macromolecules hydrophobization during compositions formation, leading to increase in their surface activity and ability to adsorption at the interfaces [2].

Based on results of study of colloid-chemical properties of compositions the assumption has been made that the most effective in application will be compositions of Hydrolized Polyacrilonitrile with surfactants at concentration ratio of $\beta=4-6$ and $\beta=0,25-0,5$.

Researches were spent on the modelling and industrial oil emulsions, the maintenance of chloride salts in the modelling emulsions has made 176 mg/l, waters- 6,1 %, and the maintenance of chloride salts in the industrial emulsions has made up to 66000 mg/l, water- 41 %. Residual content of chloride salts CCl- in the percentage to initial made up 1,4-1,5%; volume of removed water phase made up 96,6%.

It was established that the most optimal concentration ratio of polymer with surfactant at which they reveal good effect of deemulgation is the mentioned above concentration ratio, that was substantiated by their colloid-chemical properties.

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Keywords: Emulsions, colloid-chemical properties, deemulgation

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VISCOELASTIC PROPERTIES OF NOVEL THERMO-VISCOSIFYING POLYMER

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Viscoelastic fluids exhibit both the elastic and viscous characteristics when encountering deformation. The measurement of viscoelastic properties of fluids is an important aspect due to their vast practical applications, particularly in upstream oil and gas industry. The study on the viscoelastic measurements may provide several pieces of useful information, such as evolution of dynamic viscoelastic properties, viz., storage modulus and loss modulus.

It is well known that water-soluble polymers are used for controlling the rheology of the displacing fluid in oil recovery enhancement. During polymer flood operations, the viscous behavior of polymer solutions plays an important role in improving the oil recovery efficiency. Thermo-viscosifying polymers (TVP) are a novel class of materials developed for EOR applications in high-temperature and high-salinity oil reservoirs.

In this study, the viscoelastic properties of novel TVP were studied and compared with HPAM. It was found that, the 700 mg/L concentration of the novel TVP compared with a 3500 mg/L concentration of HPAM under same conditions showed good viscoelastic properties. Furthermore, it has been observed that the viscoelastic properties of the TVP at 300C and 900C temperatures predominantly exhibit a viscous behavior, as G"was always higher than G'. The novel TVP might be a good candidate as an EOR chemical for high temperature and salinity reservoirs.

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Impact of Viscous Drops on Soft Substrates

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Since the pioneering work by Worthington [1], the popularity of studies of drop impact on various, mainly solid substrates constantly rises [2] due to the relevance of this phenomenon to numerous existing and emerging technologies. However, impact of a viscous drop onto a soft surface has rarely been investigated.

The main subject of this experimental study is an impact of viscous drops of water and water/glycerine solutions on soft substrates. The experimental setup consists of a drop generator, a high-speed video system and impactor. The PDMS (Polydimethysiloxane) films, used for coating of the impactor, are prepared by mixing the prepolymer with the cross linking agent at different ratios, resulting in different mechanical properties (softness) of the substrate. Three concentrations of glycerine solution (5 wt%, 10 wt% and 20 wt%) in water were used to observe the influence of the drop viscosity on the outcome.

The evolution of the spreading diameter has been characterized using image processing. In the experiments the softness of the film has minor effect on the maximum spreading diameter (Dmax), however, it affects the receding time of the droplet (see Figure 1). The receding phase is shown to be hindered by the softness of the underlying soft substrate.
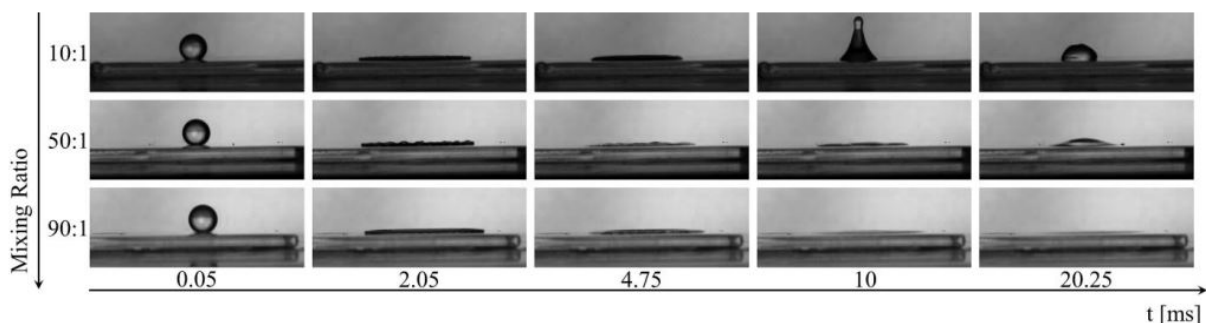
Fig 1: Water droplet impacting different substrates from hardest (10:1) to softest film (90:1). The advancing is inertia dominated while the receding phase is influenced by the softness of the underlying PDMS films.

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Keywords: Viscous drops, Weber Number, Soft substrates

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Stabilization of foams by mixtures of high-molecular natural surfactants

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The problem of obtaining highly stable foams from low cost blowing agents is of interest to many researchers. Foaming agents from natural compounds, plant materials and animal products are used by man for food production and for some technological processes for several millennia [1], [2]. Since the keratin-containing raw materials of our country and other natural ingredients available, it makes it possible to produce high-molecular foaming agents at an affordable price.

The purpose of this work is to process scientific and technical principles of production of new composite foam concentrates from natural raw materials, and the determination of their colloid-chemical properties, the development of easy and cheap synthesis of surfactants based on natural products.

In this paper we studied colloid chemical properties of high-molecular natural surfactants such as keratin hydrolyzate (1,5-15%), gelatin (0,1-1%) and egg albumin (0,1-1%) in a several concentration range. Foaming ability and foam-stabilizing properties of mixtures of these proteins was established. High stability of foams obtained from mixtures of surfactants can be explained by formation of mixed structured layers from the surface active associates promoting thickening of foam films [3]. The foam parameters such as surface tension, capillary pressure of the Plateau-Gibbs channels, radii of curvature, critical micelle concentration and relative viscosity were defined. The high surface activity and foam stability corresponds to a pH close to isoelectric state of the proteins. This proceeds due to the conformational changes of macro¬molecules of the protein at the interface liquid – gas, forming particles of colloidal size [4]. It was determined the surface tension of different concentrations of KT, Alb, Gel as well as their mixtures (1:1). We observed that with increasing in concentration of surfactants the surface tension of solutions decrease. For mixtures of polymers is dominated the thermodynamic factor of stability (synergistic effect of reducing the surface tension) related to the formation of the surfactant associates [5].

The results can be useful for the creation of composite foaming agents for practically important industries especially in the food industry using small amounts of available surfactant polymers.

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Keywords: foam; foam stability; high-molecular natural surfactants.

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Joris Arnault[1,2],

Valentin Guillarme[1], Yves Chevalier[2], Olivier Houlbert[1]

Foams are currently used for extinguishing class B fires (flammable solvents). Spreading them onto burning liquids creates a foam blanket covering the full fire in order to suppress oxygen supply to flames. In addition to extinguishing fires, foams should also prevent re-ignition. Requirements for high-performance firefighting foams are good spreading ability onto burning liquid, high mechanical strength, heat resistance and stability under use conditions. Moreover, in order to limit the volume of foaming solutions storage in companies, active ingredients are supplied as concentrates to be diluted to 1%, 3% or 6% concentration just before supplying the fire hose.

The AFFF (Aqueous Film Forming Foam)-type foams allow a thin layer of water to spread in between the foam and the fuel thanks to the presence of fluorinated surfactants. The later compounds strongly decrease the surface tension of water (γ_w) such that water fully wets the fuel (γ_o). The spreading coefficient $S = \gamma_o - (\gamma_{wo} + \gamma_w)$ is positive when γ_w is low enough. Such full wetting of the fuel cannot be achieved with hydrocarbon-based surfactants. However, there are hard environmental concerns with fluorinated surfactants that are not biodegradable and can be toxic in the aquatic environment and even for human health[1].

New fluorine-free extinguishing foaming agents currently consist of associations of biodegradable hydrocarbon-based surfactants and polymers, mainly proteins and/or polysaccharides (gums). The challenge is to compensate the absence of fuel wetting by water with a stronger coating of foam acting as a barrier against diffusion of gases (oxygen and fuel vapors). As polar solvents are miscible with water, a polysaccharide non-soluble in alcohol such as xanthan gum is added to the foaming agent. The presence of gums stabilizes the foam as it increases the viscosity of the aqueous phase. Its shear-thinning behavior allows its easy spreading onto fires with a hose and a mechanically resistant thick coating of foam can stay on top of the liquid for long times.

Research into new formulations of fluorine-free foaming agents including polymers is the matter of studying physical chemistry of polymer-surfactant associations in order to meet the various requirements: low viscosity and high foaming ability of the diluted foaming formulation, fast spreading onto burning liquid, building a gas-tight coating with high enough mechanical strength such that no crack can appear, low drainage rate and bubble coalescence.

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Keywords: Firefighting foams; Foaming agents; Polymer-surfactant associations

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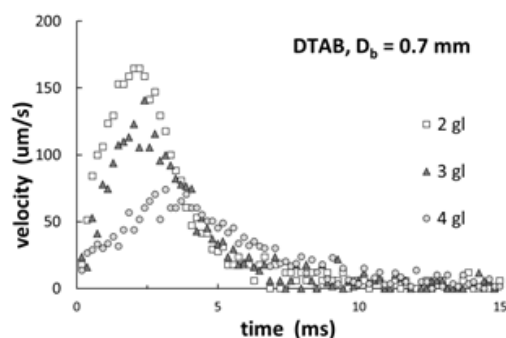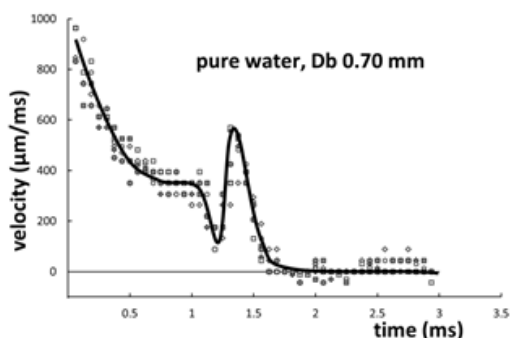# DETAIL STUDY OF BUBBLE ADHESION DYNAMICS IN AQUEOUS SOLUTION OF SURFACE ACTIVE AGENTS

Pavlína Basařová[1],

Kateřina Soušková[1]

Wetting is the process whereby a liquid displaces a gas phase on a solid surface. On the other hand, dewetting is an opposite process in which a gaseous phase displaces a liquid phase. Both wetting and dewetting are used in many industrial processes, ranging from liquid coating to tertiary oil recovery and froth flotation separation of ink particles, oil droplets, minerals and plastics. Here the velocity of three-phase contact line expansion plays an important role. Until now, molecular-kinetic and hydrodynamic models were recommended for the description of TPC line expansion. It is believed that the driving force is the difference between dynamic and equilibrium contact angles.

In our experiments, a high-speed camera was used to observe the motion of the three-phase contact line for a small rising bubble ruptured beneath a submerged horizontal hydrophobic glass plate. The camera capture frequency ranged from 16000 fps to 5400 fps in order to observe all dynamic changes of bubble motion. The experiments were performed in pure water and solutions of two ionic surfactants (SDS, DTAB). In pure water, the TPC expansion was very fast and the steady bubble capture was observed after 2 milliseconds. We observed an existence of a local velocity maximum (at 1.4 millisecond), which is related with the distribution of kinetic energy. Surface active agents decrease the bubble surface mobility. It leads to the slowdown of TPC expansion and the shape oscillations are suppressed. Further we confirmed the assumption that the TPC expansion starts with zero initial velocity. Based on the analysis of experimental data we found that both of the theoretical models fail.

INTERACTIONS OF FOAMS WITH POROUS MATERIAL UNDER MICROGRAVITY CONDITIONS

Jennifer Cook,

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Foam has become increasingly important in modern day life, with uses ranging from personal care to firefighting applications. Its ability to spread over a larger area, whilst using a smaller volume of material makes it desirable both economically and in terms of efficacy. The drainage of foam is important, incorporating both capillarity forces and gravity. However, until now, investigations of foam behaviour under microgravity condition have not been developed enough. The experimental study of foam drainage under simulation of microgravity conditions will be presented. Foams drainage in contact with porous materials in microgravity conditions (simulation) was investigated [1].

Experiments were performed by observing foam behaviour in a narrow glass cylinder placed horizontally, which simulated microgravity conditions. A side view of the schematic setup is presented in Figure 1, and a real image of the filter paper (porous material) is shown on the right.

Capillary suction induced by the porous filter paper, dried the foam and the spread radius was measured over time. This was carried out until the foam became unstable and began to collapse. The foam was successfully dried and no drainage was observed in the direction of gravity, supporting the assumption that flow through plateau borders was due only to the presence of the attached porous medium. Filter paper pore size was varied and different surfactant concentrations were investigated.
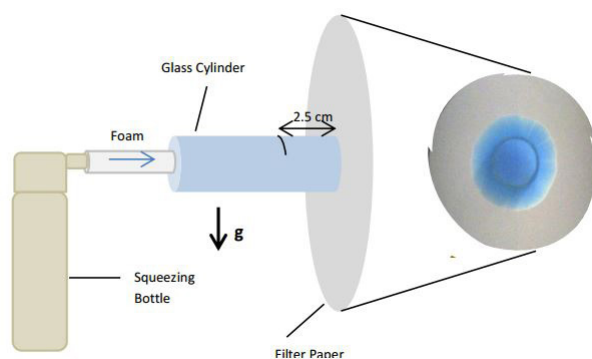
Figure 1: Experimental setup for foam drainage under microgravity conditions.

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Keywords: foam drainage, porous materials, microgravity conditions

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EMULSION STABILITY AND DROP SIZE DISTRIBUTION

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The influence of several processes variables on the stability of oil-in-water emulsions are studied in the present work. Among other parameters, we focus mainly on drop size distribution. Emulsion stability depends on a variety of factors including the intensity of mechanical agitation, the quantity of emulsifying agent and the volume fraction of oil.
The oil phase employed in this study is dodecane while the aqueous phase is a dispersion of SDS in water. Different emulsions were produced varying the following parameters: emulsification technique (Ultra Turrax vs syringe forcing), SDS concentration and the water/oil ratio by volume. By image analysis we characterized the stability by evaluating the temporal evolution of the emulsion volume with respect to the total volume. Left panel of the Figure shows that stability increases with SDS content, moreover it is affected by the oil/water ratio and, even more dramatically, by the emulsification processes. We also combined this analysis with optical microscopy digital image processing to accurately determine drop size distribution beyond its mean value, which is the quantity obtained by Diffusing Wave Spectroscopy. As shown in the pictures on the right side, droplet size decreases with increasing SDS concentration. In fact, the increase of the surfactant molecules adsorbed at the interface significantly affects the interfacial properties of the system. Interestingly, substituting syringe with Ultra Turrax in emulsification processes yields an effect similar to increasing SDS.
The combination of these different analyses gives a consistent picture of the effects of surfactant concentration and emulsification energy on droplet size and emulsion stability.
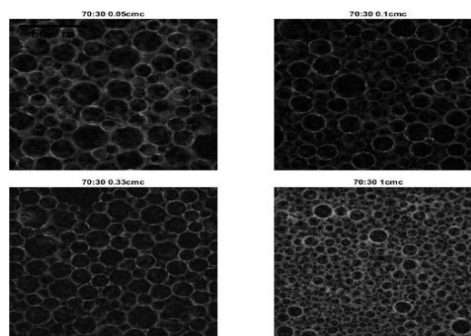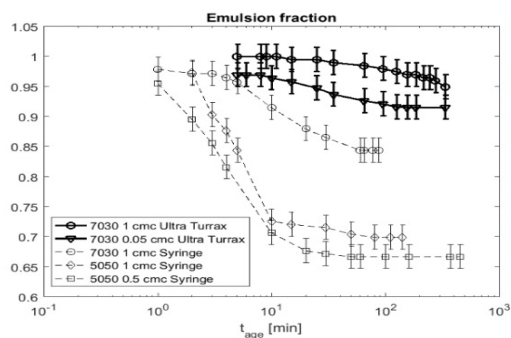
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MASS TRANSFER WITH SLENDER DROPS IN A NONLINEAR EXTENSIONAL FLOW

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Mass transfer around a slender drop in a nonlinear extensional and creeping flow is theoretically studied. The fluid mechanics problem, that was first suggested by Sherwood (1984) and recently reviewed and expanded by Favelukis (2016), is governed by three dimensionless parameters: The capillary number (Ca >> 1), the viscosity ratio (λ << 1), and the nonlinear intensity of the flow (|E| << 1). The transfer of mass around such a drop is studied for the two asymptotic cases of large and zero Peclet numbers (Pe). The results show that as the capillary number increases, the drop becomes longer, thinner, its surface area increases, leading to larger mass transfer rates, especially at large Peclet numbers, since then convection contributes to the overall mass transfer as well. Taking a slender bubble or a slender inviscid drop (λ = 0) in a linear extensional flow (E = 0) as our reference case, we find that the addition of nonlinear effects to the flow sometimes increase ($E\lambda^{-1}Ca^{-2} < 64/9$) and sometimes decrease ($E\lambda^{-1}Ca^{-2} > 64/9$) the rate of mass transfer.

$$v_r = -\frac{1}{2}Ar - \frac{3}{2}Brz^2, \quad v_\theta = 0, \quad v_z = Az + Bz^3$$
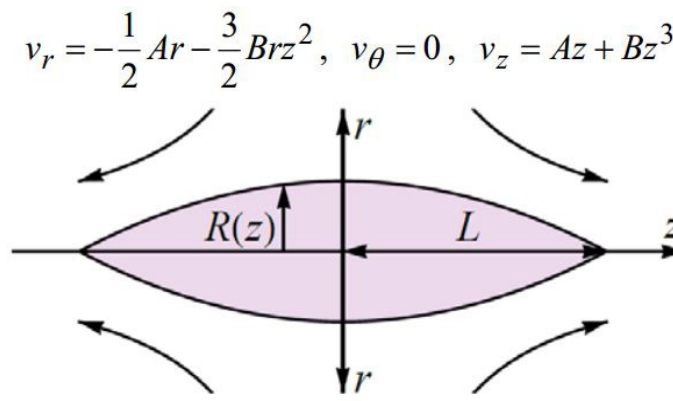
Figure 1: A slender drop in a nonlinear extensional flow. $R(z)$ is the local radius and L is the half-length of the drop. Linear flow: $B = 0$; nonlinear flow: B ≠ 0.

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Keywords: Drop; Extensional Flow; Mass Transfer

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STRUCTURED SURFACTANT LIQUIDS TECHNOLOGY:
NOVEL SUSPENSIVE SYSTEM BY SURFACTANT SELF-ASSEMBLY

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Julien Guillan, John Hawkins, Thomas Lukowicz

It is well-known that surfactants self-assemble into different phases such as lamellar phase, hexagonal phase or multi-lamellar vesicles[1]. This phenomenon is mainly driven by the surfactant concentration and its chemistry. Additional ingredients in the water phase, such as salt, also greatly impact surfactant self-assembly. Technological examples harnessing the selfassembly of surfactants are numerous. In 1985, multi-lamellar vesicles were used in the first laundry liquid to suspend sodium tripolyphosphate crystals[2,3]. The transition to the shearthinning lamellar phase observed in a great variety of surfactants, such as alkyl ether sulfate, enables the surfactant industry to manufacture these products at high concentration. Stepan Company presents here a novel technology consisting of the preparation of vesicles by the self-assembly of surfactants with defined characteristics[4]. The resulting phase shows interesting rheological behaviour such as a very high elasticity and a strong shear thinning. These properties are the attributes of a strong suspensive system, which can be particularly relevant in personal care, detergency or agrochemical formulations.

In this poster, we will see which parameters influence the formation of these self-assembled vesicles and what characterize them. Their rheological properties will also be presented. Finally, we will show examples of the implementation of this novel technology in various applications.

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FACILE METHOD FOR THE PRODUCTION OF LUBRICANT IMPREGNATED SURFACES ON COMPLEX GEOMETRIES

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G. McHale[1]

For many years, one passive way to increase the mobility of water on a surface is to make the surface superhydrophobic. By combining micro- and nano-scale roughness with chemical hydrophobicity, it is possible to create a Cassie-Baxter state on a surface[1]. The mobility of a droplet on a superhydrophobic surface is a result of the small contact area between the droplet and the surface, as the droplet sits atop of the surface features without ingressing in between.

Another way to produce surfaces that display low hysteresis characteristics is to impregnate surface roughness features with a lubricating liquid, that preferentially wets the surface and is immiscible with water[2]. These surfaces are called lubricant-impregnated surfaces (LIS). Traditionally, LIS have been made using photolithography[3] and electrospinning[4]. The issue with these methods is that they are only capable of producing small surface areas at a time and require flat geometries. Here we present facile methods using nanoparticle coatings for the production of lubricant-impregnated surfaces that can be applied in-situ to many different surface geometries. These include stainless steel meshes that have slippery surfaces on both sides (Fig.1). These modified surfaces display low sliding angles below 1°.
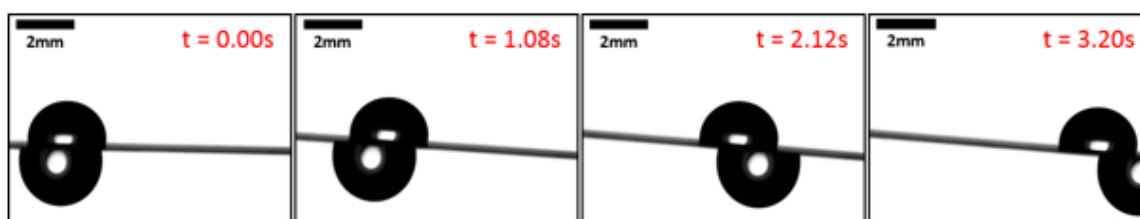
Figure 1. Time sequence of droplets sliding on both sides of a lubricant-impregnated stainless steel mesh.

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Keywords: nanoparticle, spray coating, lubricant-impregnated surface

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IMPACT OF SURFACTANT DEPLETION ON FOAM IN POROUS MEDIA

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Foam can be applied as an Enhanced Oil Recovery (EOR) process. Foam stability in porous media decreases with decreasing surfactant concentration. It is also known that foam collapses below a "limiting water saturation" in porous media. However, there isn't a complete theory for the relationship between surfactant concentration and the water saturation below which foam coarsens in a specific porous medium. The aim of this study was to find a relationship between the surfactant concentration, the foam bubble radius, and the limiting water saturation. This research gathers and analyses experimental data from the literature on foam properties in porous media. The foams were stabilized with the same anionic surfactant (AOS), at different surfactant concentrations and porous media.

The experimental data shows that for a specific porous medium, the limiting water saturation exponentially decreases with increasing surfactant concentration. These results can be explained by the surfactant depletion from the solution to the gas-water interface. This work shows that the limiting water saturation approximates the water saturation for which the gas-water interfacial-area is equal to the surface-area that could be covered by the surfactant molecules in the surfactant solution in the given porous medium. A fundamental assumption in this calculation is that gas bubbles in the porous medium correspond to pore size, as is thought to apply to foams at water saturations above the limiting water saturation.

The general implication of these results is that from two known parameters, the third parameter can be calculated (the three parameters are surfactant concentration, the average foam bubble size and limiting water saturation). A possible implication on the modelling of the foam flood in porous media was investigated in this research. The observed relationship was applied to a simulation of surfactant-alternating-gas injection in a homogenous reservoir with a uniform residual oil saturation. In this simulation the limiting water saturation was a function of the foam bubble size and the surfactant concentration.

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Keywords: Foam, EOR, surfactant concentration

ELECTROOSMOSIS IN FREE LIQUID FILM FOR THE PURPOSE OF MODELLING FLOW IN FOAM PLATEAU BORDERS AND LIQUID LAMELLA

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Foam consists of a vast number of liquid lamella that gives rise to processes that depend on surface phenomena and application of an electric field leads to interesting flow patterns within the foam structure that could result in new applications. In recent years, electric field interactions with free suspended films/soap films have gained significant interest (Hussein Sheik et al. 2016).

This paper reports on the electroosmotic flow profiles in a model system, which is free liquid film stabilised with both cationic and anionic surfactants. Experimental velocity profiles were measured using confocal μ-PIV. It was found that the resultant flow field depends on the type of the surfactant used as the shape of the film and the zeta potentials at the gas-liquid and solid-liquid interfaces are affected by the characteristics of the surfactant molecules. A computational model was also developed to predict the flow field in this system and was verified using the experimental measurements.

A liquid film holder was fabricated by connecting two transparent borosilicate glass rods with two platinized titanium rod. A liquid film was suspended in the frame by pipetting a small volume of the test solution made of deionized water, glycerol, phosphate buffer and surfactant and carefully dispensing it to the cavity of the holder to make a thin film. The liquid film was in direct contact with the electrode and the glass rods and takes the shape of a plateau borders observed in foam. By applying an electric field across the liquid film, a flow field was established using electroosmotic flow. The resultant flow field within the cell was measured by confocal μ-PIV using 2 μm polystyrene latex (PSL) particles. To account particle electrophoresis used for flow visualisation, electrophoretic mobility of the particles in the test solution was measured using Malvern Zetasizer Nano-ZS. The geometry was found by adding fluorescent dye to the free liquid film followed by optical sectioning using the confocal microscopy and image processing (3-D image reconstruction and stitching) (Hussein Sheik et al. 2017).

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Keywords: Free liquid film, Electroosmosis, Plateau border

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2017

MICROMIXING IN EVAPORATING DROPLETS CAUSED BY FESTOON INSTABILITY

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Mixing on microscale is one of the challenging problems in microfluidics. To address this problem electric or thermal fields or chaotic advection in droplets passing through a complex system of channels is applied. However, not all samples (e.g., biological) allow such influence and the existing mixing methods increase the cost of microfluidic device. To solve this problem, we proposed to use the phenomenon of festoon instability of a volatile drop placed on an insoluble liquid layer (Tarasov, Gorbacheva, 2007). The mixing is achieved by the injection of the festoons from the droplet periphery into the droplet center (Fig. 1). As a liquid substrate distilled water at temperature ranging from 24 to 45 °C was used. Isooctane, o-xylene and n-heptane were used for the droplet deposition. A 50 µl single droplet (1) was placed on the surface of 4 cm thick water layer (2), and droplet shadow (3) projected onto the flat dish bottom was recorded by a video camera and analyzed (Fig. 1). We found a linear correlation between the velocity of festoons and the substrate temperature (Fig. 1), but the functional dependence between these parameters does not exist. There are a several reasons for this: due to distortion of the droplet profile, the droplet motion relative to vapor clouds and the injection of neighboring festoons the conditions for the growth and injection for each festoon are individual and chaotic. Time required for complete droplet mixing was estimated using experimental data of the speed of the festoon injection as a function of substrate temperature. For all liquids at temperature above 30°C the droplet can be mixed 1-4 times until being fully evaporated.
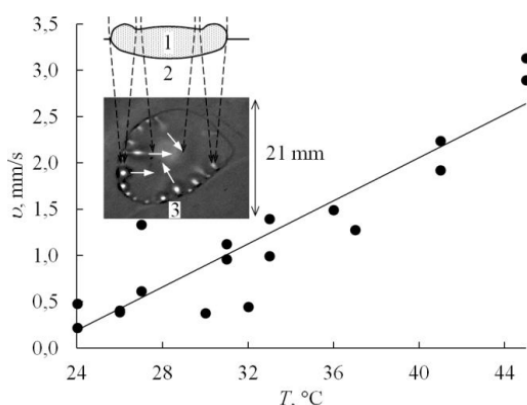
Figure 1: The festoon speed vs temperature of water layer. White arrows show the direction of the festoon injection.

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Keywords: Evaporating drop, festoon instability, drop micro-mixing.

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INFLUENCE OF N-ALKANOL CHAIN LENGTH ON ACCELERATION, LOCAL AND TERMINAL VELOCITIES OF BUBBLES

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Our paper presents the results of determination of initial acceleration, profiles of the local velocities, values of maximum and terminal velocities as well as size and shape variations of the bubbles rising in solutions of n-alkanols homologous series (C2-C10).

It was confirmed that after detachment from the capillary the bubbles accelerated rapidly, but the initial acceleration was decreased in n-alkanol solutions. Profiles of bubble local velocity showed a strong dependence on n-alkanol concentration, as expected. The values of the terminal velocity diminished drastically with increasing solution concentration, from the value of 35 cm/s in water down to about 15 cm/s in the high concentrations of n-alkanols studied. Presence of contaminations of higher surface active affected significantly the local velocity profiles in n-alkanol solutions. Interesting differences in profiles of the bubble local velocity, related to the n-alkanol chain length, were observed. Namely, in solutions of alkanols with C≤4, i.e., of lower surface activity, the bubbles always attained a plateau value of terminal velocity immediately after the acceleration stage. In the case of low concentrations of n-alkanols with C≥5 the accelerating bubbles were reaching maximum velocity and next the deceleration stage was observed prior attaining the terminal velocity. The degree of deformation (ratio between horizontal and vertical diameter) also varied with solution concentration. It was equal 1.5 in water and decreased to the value about 1.03-1.5 in the cases of high concentration of solutions studied. The effect of the adsorption rates on the behaviour of the bubble motion were also investigated and discussed for all studied alkanols concentrations. It can be concluded that the degree of the adsorption coverages diminish with the increasing of n-alkanol surface activity. Similarly, the observed differences in profiles of the bubble local velocity also can be related with the variation of studied compound surface activity.

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Keywords: Bubble motion, local velocities, acceleration, alkanols, adsorption degree

STUDIES ON HYDROGEL MATRICES BASED ON POLYSACCHARIDES

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Hydrogels constitute a group of polymers that structure is similar to the three-dimensional network. An unique property of these materials is their high sorption capacity. Hydrogels are also characterized by biodegradability and biocompatibility. Due to such features they can be applied in many areas including medicine, pharmacy or agriculture.

In the presented research two series of chitosan based hydrogels have been prepared using two types of radiation: microwave and UV. Synthesized hydrogel matrices differed in the amount of chitosan and gelatine. In the next step, physicochemical properties of such prepared materials were determined with a particular emphasis on the defining an impact of the method of the synthesis on material features. Wettability of hydrogels as well as sorption capacity have been examined. Furthermore, their surface morphology was determined. Due to the prospective applications of prepared polymers in medicine it was also necessary to check their behaviour in an environment similar to that occurring in a human body. Incubation studies have been carried out in the following solutions: distilled water, Ringer's liquid, simulated body fluid (SBF) and magnesium chloride solution.

Based on the research results it can be concluded that tested materials are characterized by a hydrophilicity regardless of the preparation method. However, polymers synthesized using microwave radiation have a greater swelling ability, greater porosity and less homogeneous surface.

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Keywords: hydrogels, polysaccharides, wettability

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NEUTRON REFLECTION STUDY OF MIXED SILICA NANOPARTICLE-CTAB LAYERS AT THE WATER/DODECANE INTERFACE

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Here we report results of a neutron reflectivity study, aimed at investigating specific features of mixed surfactant - nanoparticles (NP) layers which forms at the interface between dodecane and an aqueous Silica NP dispersion (1wt%, NP diameter 15 nm) containing the cationic surfactant CTAB. These layers result from the partial hydrophobicity of the NP-CTAB complexes [1].

Mixed surfactant-nanoparticle layers at liquid-liquid interfaces are common in nature and relevant for many products and applications. The many studies devoted to the subject, in spite providing a general understanding of these layers, have evidenced a complex interplay between the components (NP, surfactant molecules, liquid phases). In particular, differences in the surfactant content lead to peculiar structural features, which need to be clarified in order to achieve a detailed control of the properties and functionality of these layers in applications.

Due to the possibility of probing buried interfaces and the sensitivity to individual components in mixed adsorbed layers, neutron reflectivity (NR) offers interesting opportunities in the study of these systems.

In the present study, a methodology mainly developed for the NR investigation of surfactants at the oil/water interfaces [2] has been adapted to study the mixed NP-surfactant layers. Accordingly, NR experiments were performed using the INTER instrument of the ISIS facility at the Rutherford Appleton Labs. Data analysis performed within the Parrat formalism on differently matched surfactants and liquid phases (D- H- or Silicon-matched), provide pieces of information that are combined to model the quantity and location of NPs and CTAB within the interfacial layer.

We have studied the above system for a set of CTAB concentrations, to investigate the effect of the increasing hydrophobicity of the NP-CTAB complexes on the interfacial layer formation and the consequent possible redistribution of the surfactant between the different interfaces: particle/oil, particle/water, water/oil.

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Keywords: liquid-liquid interface, silica nanoparticles, CTAB, neutron reflection

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Adsorption layer dynamics at the aqueous-solution/hydrocarbon interface:
# Oscillating Drop Capillary Pressure experiments under low gravity conditions

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During the last years, we have conceived, proposed and run a set of benchmark microgravity experiments to investigate the relationships between the features of emulsions and foams (foamability, foam stability, etc.) and the physico-chemistry of interfacial layers and liquid films.

A Capillary Pressure Tensiometer (denoted as FASTER) accomplished scientific experiments on liquid interfaces in a microgravity environment, operating on board of the International Space Station. We studied the aqueous-solution/paraffin-oil and n-hexane/aqueous-solution interfaces with different concentrations of standard surfactants and at different temperatures. Harmonic disturbances were imposed to the interfacial area of a liquid drop, issued from a capillary tip into a liquid-matrix, at different frequencies, (1 to 200 Hz) and 3 amplitudes (5%, 10%, 20%). As a response, the pressure amplitudes and phases were measured in the chambers of the Capillary Pressure Tensiometer. An example for an aqueous-solution/paraffin-oil system is shown in the figure. The measured pressure signal depends on the capillary pressure of the droplet which is determined by the curvature radius variation and interfacial tension relaxation. The experiments provide access to dynamic properties of interfacial layers under conditions of their fast deformation. It is important that the system dynamics is determined not only by the capillary pressure variations but also by some concomitant effects in the bulk phases, such as bulk elasticity and hydrodynamic effects. A model was elaborated, which satisfactory describes the dynamic response of the measuring cell, providing at the same time the values of the dilational viscoelasticity.
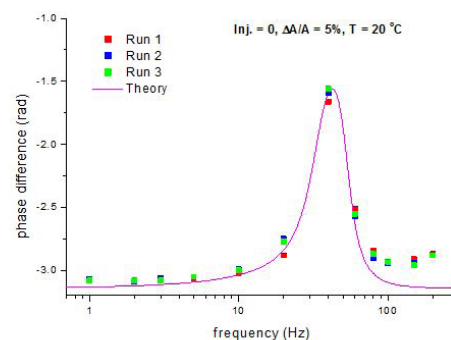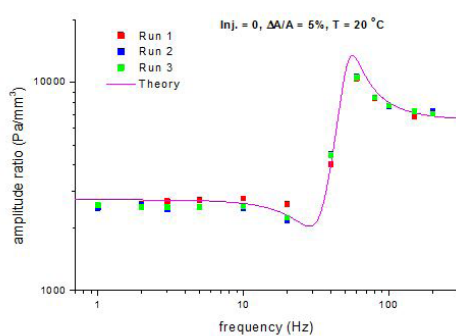
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Keywords: Microgravity experiments, Adsorption layer dynamics, Oscillating Drop

OBSERVATION OF CO2 MICRO-BUBBLE DISSOLUTION BY DIGITAL IN-LINE HOLOGRAPHY

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B19

1 Bubble & drop formation, motion, interactions

The mass transfer (dissolution) from CO_2 bubbles into a liquid medium is at the heart of many environmental, energy and health problems (sequestration, fuel production, targeted drug delivery, etc.) [1]. Despite a high number of applications, the fundamental understanding of bubble mass transfer remains challenging due to the complex, localized (bubble vicinity) and multi-scale nature of the phenomena involved [2, 3, 4, 5]. As bubble size distribution seems to be an essential parameter in the optimization of mass transfer, an approach to improve mass transfer consists in decreasing the bubble diameter in order to increase the surface exchange. Micro-bubbles have several advantages compared to large bubbles: their low rising velocity increases the contact time with the liquid phase and consequently enhances the transfer rate through the interface. Yet, the study of such bubbles requires threedimensional temporal tracking (*x, y, z* in addition to size), which can prove tricky to achieve. The observation of small objects requires high image magnification, which leads to a significant decrease in the depth of field and makes it difficult to track bubbles.
To overcome this problem, we propose an original approach based on the use of digital in-line holography (DIH). DIH makes it possible to realize a Lagragian tracking of small objects [6] and to observe the hydrodynamics and dissolution of micro-bubbles. Bubbles are injected in a 10 cm-edge cubic water tank using a syringe pump. Experiments are conducted in bi-distilled water and bubble diameters range from of 100 to 1000 μm. Firstly, the hydrodynamic behavior of rising air micro-bubbles is compared to the literature to validate the optical method. Secondly, the dissolution behavior of small rising CO_2 bubbles is studied and compared to a multicomponent gas exchange model [1].

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Keywords: Bubble dissolution, digital in-line holography

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BULK AND INTERFACIAL FLOWS IN THE COALESCENCE OF SURFACTANT-LADEN AND SURFACTANT-FREE DROPS

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B20

1 Bubble & drop formation, motion, interactions

Coalescence of drops was studied for more than a century with different focuses, for instance on the time before merging occurs [1], strongly related film drainage from between the drops [2] or kinetics of the bridge expansion [3]. The flow accompanying the merging of drops in binary coalescence events has been investigated in the literature. The coalescence of drops of different properties, however, has received far less attention despite its importance to a plethora of industrial applications; these include tightly-controlled merging of reactants, different emulsions, and the formation of bespoke multiphase structures, which deliver specific function via novel manufacturing routes.

This study is aimed at providing a thorough understanding of the merging process immediately after the rupture of the thin liquid film separating the drops initially. Coalescence of two aqueous drops, one containing surfactant and the other surfactant-free, in silicone oils of various viscosities, was studied. It is observed that the surfactant-free drop intrudes into the surfactant-laden drop in the form of a penetrating jet whose speed increases and average radius decreases with increasing outer phase viscosity. Mixing patterns within the coalescing drops are due to the force imbalance caused by capillary pressure difference and surfactant-induced Marangoni stresses; the intensity of the convective bulk motion is also influenced by the viscosity of the outer phase. Numerical simulations provide a deeper insight into the liquid redistribution during the merging. Their results are in good agreement with the experimental data and will be discussed during the talk.

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Keywords: Please give three keywords

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WETTING DYNAMICS OF NANO-DROPLETS ON VIBRATING SURFACES

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The study of acoustic wave propagation in fluids ('acoustofluidics') has traditionally been motivated by macro-scale flows involving large water bodies[1]. However, recent progress in micro/nano-fabrication technologies has resulted in the development of micro/nano-scale acoustofluidic lab-on-a-chip devices, with applications across chemistry, biology, and medicine[2,3]. These devices typically use large-amplitude, high-frequency (MHzGHz) sound waves to manipulate micro/nano-droplets on surfaces of varying wettability. Due to the small length scales (nm) and time scales (ns) involved in the acoustic wave dissipation

inside the droplet, nanodroplet acoustofluidics cannot be modelled by conventional continuum-based techniques[4]. Molecular dynamics[5], a simulation method which tracks the motion of individual molecules, represents an accurate computational tool to study systems at such small scales.

In this presentation, we report the results of an investigation into acoustofluidics using molecular dynamics, for the simple problem of water-nanodroplet wetting on an oscillating surface. The wetting behaviour is shown to be significantly influenced by the size of the droplet, the wettability of the surface, and the frequency and amplitude of the applied oscillations.

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Keywords: Molecular dynamics, droplets, acoustics

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Heat of bubble formation and Surface pressure

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B22

1 Bubble & drop formation, motion, interactions

The heat rate of bubble formation in several different liquids is measured for the first time by use of a standard Isothermal Titration Calorimeter. The kinetic calorimetric profile exhibited a fully reproducible signal that depends dramatically among other factors on the liquid contained in the calorimetric cell. The obtained experimental results are presented, together with a rough analysis of the signal and some proposals to improve the method by slightly modifying the injection system in the instrument. As a first direct application, it is shown that this method, with no modifications at all in the employed instrument, is well suited to determine surface tension of liquid samples with high precision, as long as a good calibration line is established making these measurements in liquids of known surface tension. The thermodynamic and kinetic characterization of bubble formation and release in different liquids is expected to be a key information for the study of foams in different solvents, while the strong dependence on the liquid composition and the possibility of following the signal as a function of time is promising in the characterization of adsorption mechanisms of macromolecules (industrial polymers or biomolecules) or liquid/vapor interfacial films' formation

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Keywords: Bubble formation, calorimetry, surface tension

SECOND HARMONIC GENERATION FROM SOAPY INTERFACES

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Foams are commonly used in a large range of applications as for instance, in chemistry as well as in structure material science. Therefore, numerous investigations of the mechanical and rheological properties of foams have been performed. However, their macroscopic behaviour is intimately bound to the microscopic properties of soapy interfaces. The spatial distribution of surfactants and their dynamics remains so far poorly understood, mostly because of the lack of techniques to characterize soapy interfaces at molecular scale.

Second order nonlinear optical techniques, and in particular Second Harmonic Generation (SHG), are powerful tools to characterize interfaces as this optical phenomenon only takes place where the centrosymmetry is broken [1]. In surface SHG experiments, a pulsed laser at a frequency ω is focused on the studied interface and the signal generated at the double frequency is recorded. The properties of the interface, formed by surfactants and solvent molecules, are then derived from the analysis of the 2ω beam intensity and its polarisation. Amphiphilic chromophores, designed to have a great SHG response, at air/liquid interfaces have extensively been studied by this method. Surface concentration, molecular organization or dynamics have thus been reported in detail [2,3]. However, very few works have considered the case of molecules which do not have particular optical features adsorbed on surfaces [4]. The principal reason stems from the difficulty to establish a clear link between the non-linear optical signature of the interface and the surfactant molecule properties.

In this work, we present our recent results on non-chromophoric surfactant molecules adsorbed at the air/water interface through SHG measurements. We particularly focus on surfaces covered by standard foam surfactants of different nature, such as SDS and TTAB for instance, while varying the solution concentration. By comparison with other surface characterization methods such as surface tension, we discuss the origin of the SHG signal observed and draw a picture of the surfactant behaviour at soapy interfaces.

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Keywords: Nonlinear optics, soapy interfaces, surfactant organisation

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CONTACT ANGLES OF FAT CRYSTALS DETERMINED BY ATOMIC FORCE MICROSCOPY IMAGING.

Damien Sebben[1],

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Dairy emulsions have a particular important aspect that makes them near-unique: the presence of solid fat crystals within the liquid fat phase. The interfacial behaviour of these solid fat crystals will determine the stability of the emulsion. In addition to two boundary conditions (i.e. droplets not merging for stable emulsion and droplets merging for unstable system) dairy emulsions can undergo partial coalescence, where droplets attach to each other and share their inner liquid content. However, the droplets maintain their individual shape due to the presence of fat crystals at the interface and in the interior of the droplet, acting as scaffolding to prevent full coalescence (instability). Association of fat crystals at the interface is a reflection of the fat crystal wettability. The classical way of measuring contact angle in such systems is with captive droplet, where a droplet of liquid fat is pressed against macroscopic samples of mixed crystalline solid fat phases. However the surface area to volume ratio of these experiments can result in unrealistically large concentrations of surface active phospholipids, mono-glycerides, and proteins at the interface of the liquid and solid fat. The size of fat crystals responsible for partial coalescence is 1000 times smaller and the contact angle measurements must be approached from a microscopic perspective if one wishes to get representative measurements.

We used a tapping mode Atomic Force Microscopy (AFM) to image nano- and/or sub-micron fat droplets deposited on single fat crystals in aqueous environment (the composition of which has been altered). The AFM images allowed us to extract the contact angle of the fat droplet from the droplets cross-section. We observed the changes in measured contact angles were dependent on the nature of aqueous solution composition. Also, the microscopic contact angles measured with the AFM were different to those measured with a captive droplet on macroscopic sample of mixed crystalline solid fat.

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COMPETITIVE ADSORPTION OF TRICLOSAN AND ITS DERIVATIVES FROM MIXED MODEL SYSTEMS IN WASTE WATER TREATMENT BY THE SORBENTS

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Triclosan is an antimicrobial active component in consumer care products such as toothpaste, mouthwash, and soaps, as well as in household cleaners and even in textiles, such as sportswear, bed clothes, shoes, and carpets. The widespread use of Triclosan provides a number of pathways for the chemical to enter the environment, and laboratory tests have shown that it si toxic to aquatic species. The chemical properties of Triclosan indicate that it may also bioaccumulate and persist in the environment. Due to the uncertainty in estimating environmental release by this pathway, no predicted environmental concentration (PEC) in surface waters has been derived yet.

In this work, the adsorption of Triclosan and its derivatives (methyl Triclosan, 2,4-dichlor phenol, 2,4,6-trichlorphenol, 4- chlorocatechol) as model systems were studied separately and in mixtures by using the sorbent «ISQDON-GW», obtained by Portuguese colleges (Dr.Lyubchik and O.Lygina).
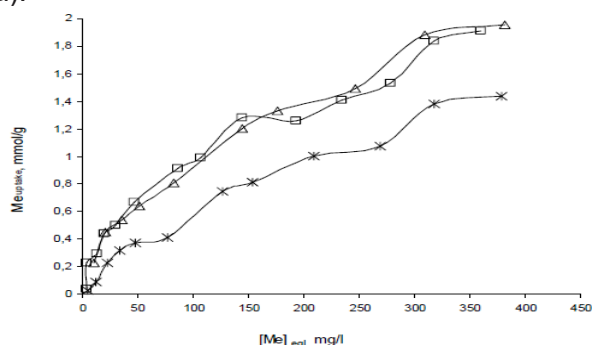

Fig 1- Adsorption from multicomponent model systems (£) – 2,4- Dichlor phenol (2,4-DCP); (r) – 2,4,6- Trichlorphenol (2,4,6-TCP), (Ú) – Triclosan by «ISQDON-GW» sorbent

According to the obtained results, the uptake of multicomponent model solutions is higher than for the single component solutions due to competitive adsorption. The adsorption capacity for Trichlorphenol is 140mg/g, for Triclosan 110mg/g, and for 2,4-dichlorphenol (2,4-DCP) is 125mg/g.

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WATER VAPOR CONDENSATION ON ICE

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Wenceslao González-Viñas

Condensation patterns are structures formed on a substrate where drops are begun to show up, directly coming from their vapor phase (i.e on the substrate occurs a first order phase transition). The evolution of Breath Figures strongly depends on substrate properties (e.g. wettability) as well as on environmental conditions (Beysens, 1986; Beysens, 2006). Also, desublimation patterns are analogously called Breath Figures. In nature, condensation patterns correspond to dew and desublimation patterns to frost. Both phenomena are very relevant for technological applications and for the society well-being (recovery of water from the atmosphere either to drink or to water crops,...)

If the temperature of the substrate is lower than the freezing point, Breath Figures can appear either directly by desublimation of the vapor, or by condensation (as supercooled water) followed by freezing droplets by different mechanisms (Guadarrama-Cetina, 2013).

As a matter of fact, condensation to supercooled water on ice is unstable and, thus, does not occur in normal conditions. However, if the ice temperature is close to the freezing point, the latent heat released on condensation may sustain condensed water droplets on ice. On the other hand, it is relevant the atmosphere-mediated interaction between ice and (supercooled) liquid water through the Wegener–Bergeron–Findeisen process.

In this work, the substrate is ice previously frozen at a fixed temperature. Ice is placed in a condensation chamber wherein water vapor saturated air at room temperature is streamed. We will report experimental results about the evolution of the Breath Figure morphology, specially its statistical properties. We will shed light onto the different modes of growth of the structure at several experimental conditions.

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Keywords: Frost formation, condensation, Breath Figures

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SURFACE ACTIVITY OF CLEAVABLE AMIDEQUATS

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From the ecological point of view, chemical compounds should be safe for environment and human health without undermining their function and efficiency. Therefore, there is a quest for surfactants that can be used and then subjected to the degradation, triggered by some external or environmental factor (pH, temperature, UV-radiation, enzymes), to safe or not active products. We analysed theoretically and experimentally the surface properties of amidequat-type, cleaveable surfactants: [3(dodecanolylamino)propyl]trimethylammonium bromide (C12PATMBr), and (N-dodecylcarbamoylethyl)trimethylammonium bromide (C12ETMBr). Their surface activity depends on the rate of their pH controlled hydrolysis and is determined by the composition of a mixture of substrates and products of hydrolysis reaction appearing in the solution. Those components may interact with each other, forming surface complexes that significantly change surface activity of the solution.
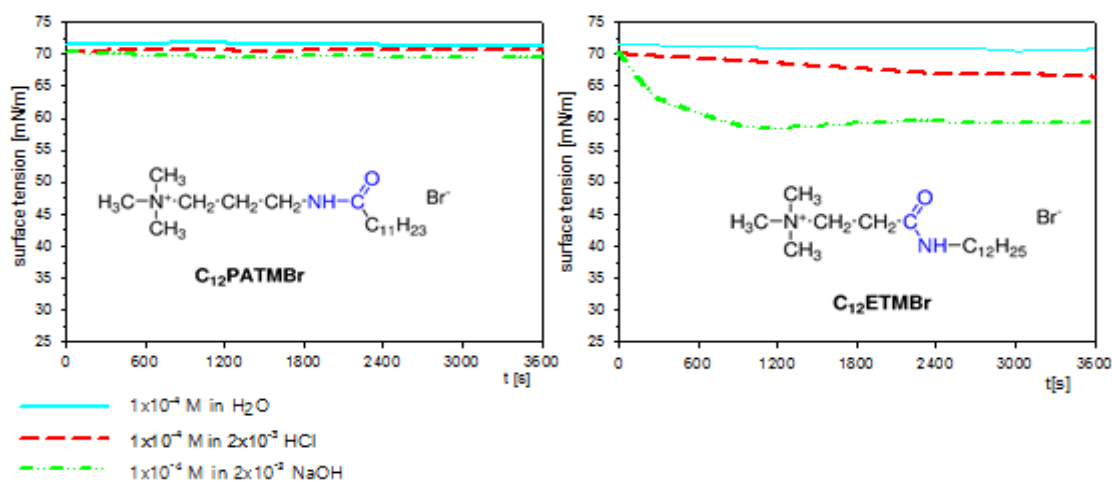
Fig 1. Chemical structures and abbreviations of the studied compounds and its dynamic surface tension dependence on different pH of solution.

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Keywords: cleavable surfactants, amidequat, hydrolysis,

Motion of a spherical drop with insoluble surfactant in microfluidic channel

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Bofeng Bai[2]

The motion and deformation of drops in a microfluidic channel can serve as a typical sub-pore scale model for understanding the dynamics of two-phase flows through porous media, which is ubiquitous in nature and applications such as oil recovery and droplet microfluidics[1]. Particularly, the relations between the pressure gradient and the flow rate of each phase is of great practical importance for developing upscaling models such as pore scale and pore-network model, even macroscopic continuum model. Numerous studies have been focused on the motion of drops in a cylindrical tube owing to its simplicity within axisymmetric geometry. Nevertheless, extensions to studying drop motion in channels with more complex geometries, for example square or rectangular cross-section, are essential, since these complex cases are more commonly seen in practice, such as microfluidics and reservoir porous media. Another important issue to be considered is the involvement of surface-active species in the form of contaminants, impurities or additives. For instance, chemicals such as surfactants and polymers are currently used for enhanced oil recovery; besides, surfactants are extensively used to stabilize droplets in microfluidic technologies.

In this study, we present a systematic analysis on the effects of insoluble surfactant on the motion and deformation of a spherical drop in a square microfluidic channel. Our work is realized through a three-dimensional front-tracking finite-difference model, which we developed previously for the study on the dynamics of capsules surrounded by membranes with complex mechanical properties[2,3]. Here, we further develop this method via introducing the governing equation for the convection and diffusion of surfactant on drop surface. Using this model, we study the effect of surfactant-induced interfacial mechanics, e.g., the Marangoni stress, on the motion and deformation of drops in square channel. Particularly, we analyse the effect of insoluble surfactant on the relation between the pressure gradient and the flow rate.

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Keywords: Drop motion, insoluble surfactant, front tracking method

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AMPHIPHOBIC COATINGS FOR ANTIFOULING IN SEAWATER ENVIRONMENT

Michele Ferrari, Libero Liggieri,

Francesca Cirisano, Alessandro Benedetti,Francesca Ravera, Eva Santini

POSTER

8 Wetting and spreading

Amphiphobic materials represent a relatively young emerging field achieving growing interest as innovative solution, meeting technological and ecological aspects, taking into account the limitations imposed by international laws in terms of environmental protection.

In this work different coatings dedicated to the marine environment, showing highly water and oleo repellence, have been compared for applications and characterized and tested both in laboratory and field conditions, considering investigations in real seawater as crucial to evaluate the behaviour of such surfaces in complex environments not reproducible in laboratory.

Also preliminary tests for wearing, thermal stress and durability have been carried out in order to study amphiphobic systems for other applications related to the marine environment

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Keywords: amphiphobic, antifouling, coatings

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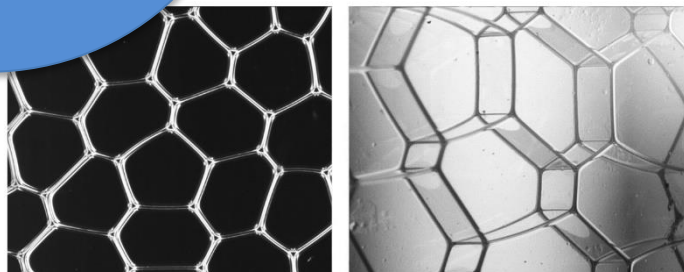

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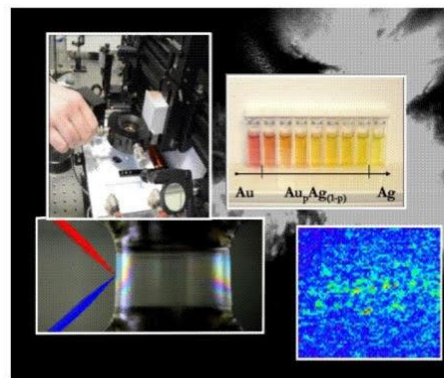
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