Corrigendum: Improved analysis and visualization of friction loop data: unraveling the energy dissipation of meso-scale stick–slip motion (2017 Meas. Sci. Technol. 28 115011)

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Corrigendum: Improved analysis and visualization of friction loop data: unraveling the energy dissipation of meso-scale stick–slip motion (2017 *Meas. Sci. Technol.* 28 115011)

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In this corrigendum we point out a mathematical error in our manuscript and review the consequences. None of the conclusions of the paper were impacted by the mistake. However, the original calculation and interpretation of the dynamically dissipated energy was incorrect. This resulted in two misleading figures, of which we include the corrected versions here.

1. Introduction

In our original manuscript [1], we introduced a new type of friction loop, in which the lateral (friction) force was plotted as against the x-position of the contact point on the sliding surface, instead of an equivalent of the cantilever support position of a friction force microscope (FFM). These loops are more intuitive than traditional FFM-style friction loops. They consist of continuous sections of dry friction, that are connected by 'data-less' gaps, where the coulomb limit is exceeded and the contact moves to the next stick location, faster than we can measure. In contrast to the FFM-style friction loops, the surface area of the new loops does not directly represent the dissipated energy: only the surface area below the continuous parts really represents dissipated energy. We called this energy semi-statically dissipated energy. No surface exists in the gaps between the stick locations, so the dissipated energy during these sliding motions cannot be found by numerical integration.

2. Mistakes

In the original paper we correctly stated that despite the absence of data during the slip motions, we still know how much energy is dissipated. The amount of energy stored in the mechanical springs just before the slip occurs, minus the potential energy in the springs after the slip occurred, must be equal exactly to the amount of energy dissipated during the slip motion, because of the law of conservation of energy. Potential energy is stored in the spring, it starts to slip, potential energy is converted to kinetic energy, after a while the contact gets stuck and the remaining kinetic energy is converted to heat.

We explained that the dynamically dissipated energy equals the surface area of the triangles below the slip arrows (see figure 1(a)), excluding the remaining rectangle area between this triangle and the x axis. This claimed was backed up by an incorrect mathematical equation with a subtly hidden mistake: $(a+b)^2 \neq a^2+b^2$. Because we forgot about the factor $2ab$, we simplified the equation more than possible (equations (20) and (21) in [1]).

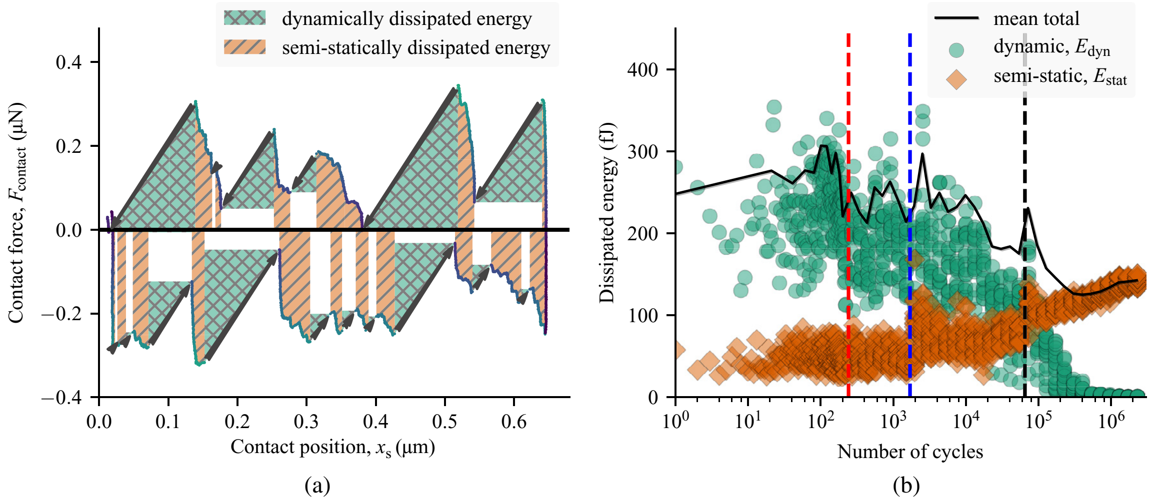

Figure 1. The original figure. The friction loop in figure (a) incorrectly shows green shaded areas to represent the dynamically dissipated energy. The evolution of the dissipated energy in figure (b) incorrectly shows that the dynamically dissipated energy decreases to zero after many sliding cycles.

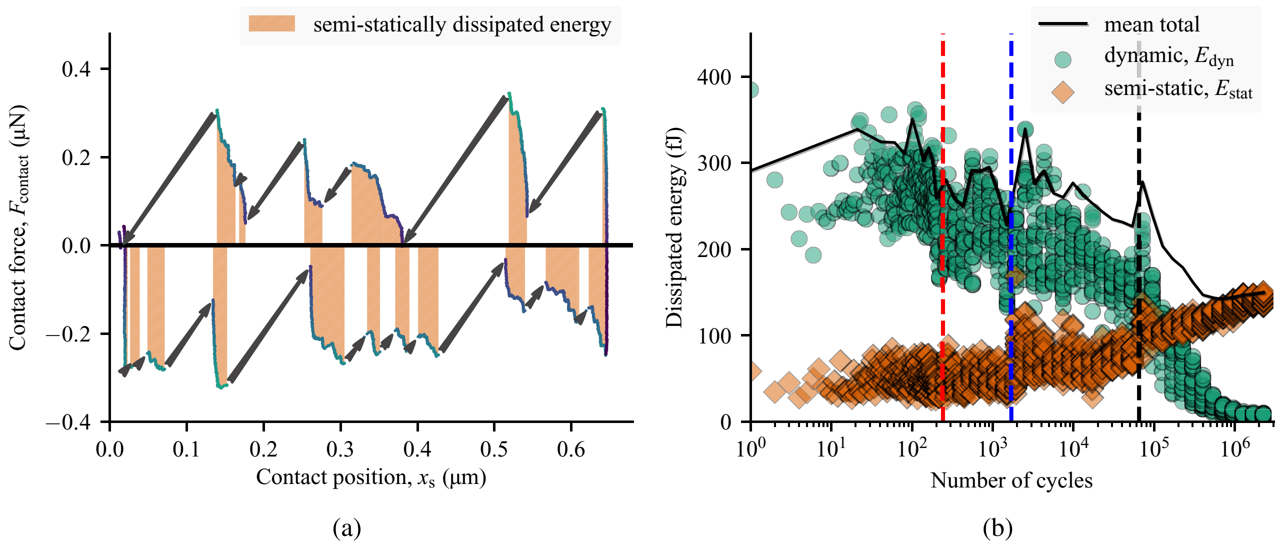

Figure 2. Corrected figure. In figure (a), the dynamically dissipated energy is no longer displayed in the friction loop as a shaded area, because it does not correspond to a surface area on these axes. In figure (b), the dynamically dissipated energy does not approach true zero, but a small value close to zero instead.

3. Corrections and conclusion

Fortunately, none of the main conclusions of the original manuscript depend on the incorrect math. However, the error did result in an incorrect shaded visualization of the dynamically dissipated energy in figure 1(a). A corrected version is shown in figure 2(a). We have chosen to omit the shading of the dynamic friction parts of the friction loop (the arrows) entirely, because the dynamically dissipated energy does not correspond to an area of the graph in a sensible way.

The exact values of the dynamically dissipated energy plotted against the number of sliding cycles in figure 1(b) also change, but only subtly. The corrected version is shown in figure 2(b). Most notably, the dynamically dissipated energy does not actually go to zero, but approaches a value very close to zero instead.

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Reference

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