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Real contact area reduction under shear in elastomer/glass contacts: wide range of normal loads and effect of a small misalignment

Davy Dalmas[1)], Mariana de Souza[1)], Julien Scheibert[1)]

[1)] Laboratoire de Tribologie et Dynamique des Systèmes LTDS UMR5513, Univ Lyon, Ecole Centrale de Lyon, ENISE, ENTPE, CNRS, Ecully, France
*Corresponding author: davy.dalmas@ec-lyon.fr

In this paper, we investigate experimentally the dynamics of elastomer/glass contacts near the transition between static and kinetic friction by monitoring the evolution, under increasing shear, of the real area between a cross-linked polydimethylsiloxane (PDMS) sphere and a smooth glass plate for the widest loading range in the literature. Then, we show the unexpected strong effects of a small misalignment on the contact dynamics and more specifically on the mechanisms responsible for the area reduction.
Keywords: Friction, Contact mechanics, Elastomers, In-situ visualization

1. Introduction

Contact mechanics of elastomers is a crucial but complex issue in many applications [1] such as transportation (tires, seals…), daily-life (sports shoes, flooring…) or biomedical (syringe seals, implants…). In recent years, shear experiments performed on PDMS/glass model interfaces (planar rough/rough or smooth sphere/plane) have shown that such interfaces exhibit a significant asymmetric reduction of the real contact area with the increase of the tangential force [2]. Unfortunately, different models seem to capture this observation, but with different assumptions. Here we propose to expand the available corpus of experimental data, that we hope will be useful to discriminate between models.

2. Methods

In this context, with the same experimental set-up as in [2], we further study the dynamics of elastomer/glass contacts near the transition between static and kinetic friction by monitoring the evolution, under increasing shear, of the real area between a cross-linked polydimethylsiloxane (PDMS) sphere and a smooth glass plate (see Figure 1).

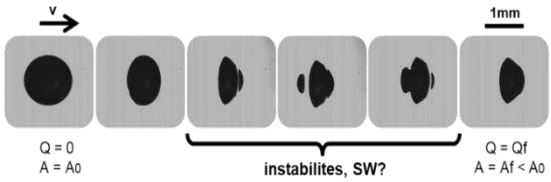

Figure 1: In-situ visualization of the evolution of the real contact area between a sheared elastomeric sphere and a glass plate

First, for an extended range of normal forces compared to the literature, from -0.001N to 5N, we confirm the existence of a significant asymmetric reduction of the contact area even at very low normal forces (i.e. when the adhesion forces become dominant). Those results can be used to test recent models (e.g. [3]) to decipher the role of adhesion.
Second, we report experimental observations and quantitative measurements introducing a small initial misalignment between the interface and the shearing direction (see Figure 2). We show the unexpected strong effects on the contact dynamics and more specifically on the mechanisms responsible for the area reduction (peeling or laying down). Those results further suggest the need to care about and account for such tiny misalignment both in the design of experimental set-ups and in the analysis of the measurements.

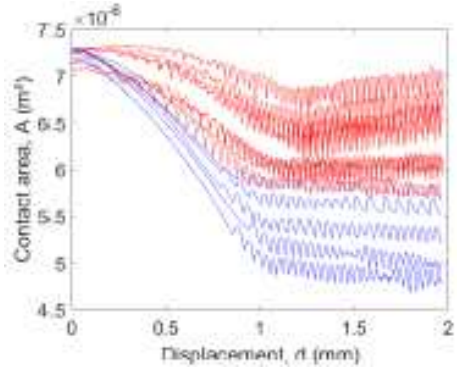

Figure 2: Evolution of the real contact area as function of the displacement for misalignment ranging from -4° (blue curves) to +4° (red curves).

3. References

[1] Persson, B.N.J., Springer, Berlin, 2000.
[2] Sahli, R., Pallares, G., Ducottet, C., Ben Ali, I. E., Al Akhrass, S., Guibert, M., Scheibert, J. (2018). Proceedings of the National Academy of Sciences, 115 (3) 471-476.
[3] J. Lengiewicz, M. de Souza, M.A. Lahmar, C. Courbon, D. Dalmas, S. Stupkiewicz, J. Scheibert, Finite deformations govern the anisotropic shear-induced area reduction of soft elastic contacts, Journal of the Mechanics and Physics of Solids, Volume 143, (2020)