

An optimization-based framework to design metainterfaces with tailored friction laws

Li Fu¹, Djibril Gabriel Kashala², Davy Dalmas³, Julien Scheibert⁴

¹ CNRS, Ecole Centrale de Lyon, ENTPE, LTDS, UMR5513, France. li.fu@ec-lyon.fr

² CNRS, Ecole Centrale de Lyon, ENTPE, LTDS, UMR5513, France. djibril.gabriel-kashala@ec-lyon.fr

³ CNRS, Ecole Centrale de Lyon, ENTPE, LTDS, UMR5513, France. davy.dalmas@ec-lyon.fr

⁴ CNRS, Ecole Centrale de Lyon, ENTPE, LTDS, UMR5513, France. julien.scheibert@cnrs.fr

Paper ID: 185

[Symposium S4: Mechanics of architected materials: Experiments and modelling](#)

Abstract

Providing dry solid contacts with on-demand macroscale frictional behaviour remains a grail in tribology, haptics or robotics. Metainterfaces created from surfaces with engineered asperity-based topographies can achieve such friction control. However, only few friction behaviours were demonstrated because suitable topographies were identified based on human intuition [1]. Here, I will introduce a numerical-optimisation-based inverse design framework to automatically discover new metainterfaces satisfying specified relationships between friction and normal forces (friction law). To illustrate the framework's versatility, I will show how to (i) expand the range of achievable friction coefficients at a constant material pair (ii) unlock power-law friction laws with arbitrary exponents between $2/3$ and 1 , and (iii) achieve bilinear laws with a smaller slope in the second segment than in the first. Relevant cases will be validated experimentally. By systematically exploring large parameter spaces, not limited to topography but potentially incorporating the individual asperities' bulk material or surface physicochemistry, this automated framework offers design solutions for any physically possible friction law. It also provides new insights into the elusive relationship between local interfacial properties and macroscopic friction [2].

Keywords:

metainterface friction law inverse design genetic algorithm tribology

References:

- [1] A. Aymard, E. Delplanque, D. Dalmas, J. Scheibert, Designing metainterfaces with specified friction laws, *Science* 383:200-204, 2024.
- [2] A.I. Vakis, et al., Modeling and Simulation in Tribology Across Scales: an Overview, *Tribol.Int.* 125:169-199, 2018.