Preface

This work presents a novel friction simulation toolset, the **Mi**cro**me**chanical **A**sperity **C**reep (*MIMEAC*) friction simulation environment. This toolset permits the multi-scale, transient simulation of, e.g., friction-induced vibration phenomena by co-simulating the surface physics and the macroscopic system.

The theory is based on two assumptions: First, rough surfaces are inherently fractal, exhibiting roughness on a wide range of scales. Second, transient friction effects are caused by creep enlargement of the real area of contact between two bodies. At the core of the theory lie extensive finite element analyses of the creep behavior of surface asperities, modeled by elastic-perfectly plastic hemispheres in contact with a rigid flat. The simulations are condensed in a scale-independent, parameterizable model with just two degrees of freedom per asperity. The condensed model is used as a building block for the time-dependent, multi-scale calculation of the real contact area between two surfaces, based on the Jackson–Streator area iteration. The transient dynamics due to creep are included by virtue of the assumption of a per-scale junction age, which is calculated based on both the lateral displacement and the normal loading history.

The model is first analyzed for static contact, for which new analytical solutions are presented. Focusing on dwell time-, velocity-, and normal force-dependent friction transients, the predictions for transient contact are then compared with published results from experiments. The results are found to be in good agreement. In addition, a novel mechanism is found which could potentially excite friction-induced oscillations by the asperities themselves, without the involvement of the macroscopic system.

The usefulness of the MIMEAC toolset for system design and analysis is demonstrated in two example models. One uses an abstract description of a simple friction oscillator with just two degrees of freedom, the other describes a similar system, however, modeled by the finite element method.

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