EXOTIC BEHAVIOR OF REACTIVE-WETTING OF METAL ON METAL-ON-GLASS IN ROOM TEMPERATURE

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Abstract: *We present non-trivial spatio-temporal patterns observed in reactive-wetting of mercury droplets spreading on thin metal (silver or gold) films on glass at room temperature. This is the only known study of reactive-wetting at room temperature. We show that there exist two main regimes, the bulk propagation regime and the interface kinetic roughening regime. In both regimes, rich spatio-temporal patterns are observed. We study and characterize these patterns using statistical physics tools, such as the growth, roughness and persistence exponents, and show the manifestation of surface tension relaxation in these statistical measures.*

Keywords: Reactive-Wetting, Metal-on-Glass, Contact Angle, Surface Tension, Kinetic Roughening, Growth, Roughness, Persistence

Mercury droplets (150 microns in diameter) were placed on thin metal films (silver and gold in various thicknesses) evaporated or sputtered on glass, and their spreading has been studied using an optical microscope. The top-view images have been translated into side-view profiles, based on the various colors obtained using reflection-DIC (Differential Interference Contrast) light microscopy. The idea is that the object reflects light from different points of its surface with different colors that are indicative of its surface slope at each point.

The propagating interface of the droplet undergoes kinetic roughening. The two main regimes in the entire process, the bulk propagating and the kinetic roughening regimes, are shown in Fig. 1, for a mercury droplet spreading on a silver thin film of 4200 A.

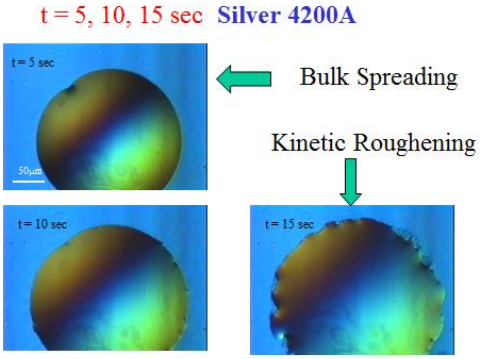

Fig. 1 *The two main regimes of the process.*

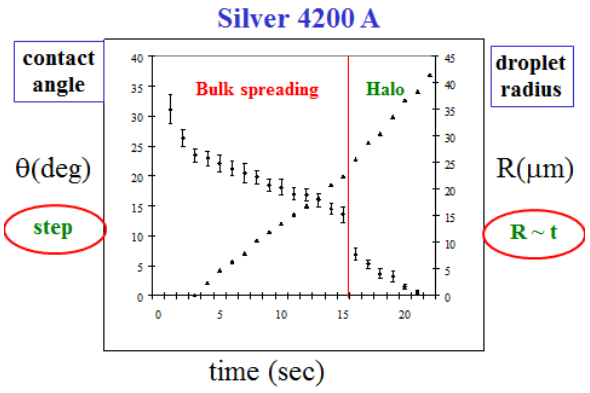

Fig. 2 *The droplet radius and contact angle as a function of time in the bulk spreading regime.*

Bulk Spreading

In the absence of a theoretical framework for reactive-wetting systems, we obtained empirical results for the droplet radius and the contact angle, both as a function of time. The radius was shown to grow linearly with time, and the angle exhibits a step at a time related to the glass thickness (Fig. 2).

Kinetic Roughening

Using statistical physics tools, we were able to calculate the so-called growth, roughness and persistence scaling exponents, from which we could identify three sub-regimes in the kinetic roughening of the interface – noise, non-linear growth, and surface tension relaxation, as shown in Fig. 3. The results were found similar to results in conventional *high*-temperature reactive-wetting systems. This universality feature is exemplified in Fig. 4.

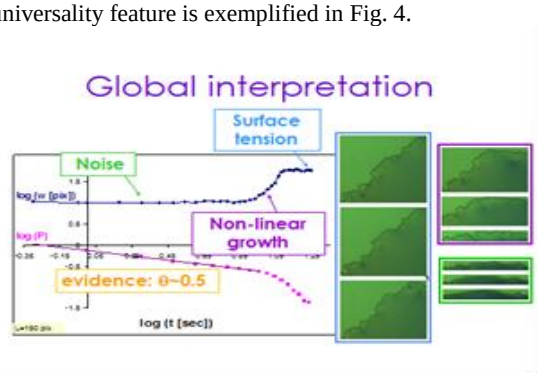

Fig. 3 *Noise, non-linear growth and surface tension relaxation in the kinetic roughening regime.*

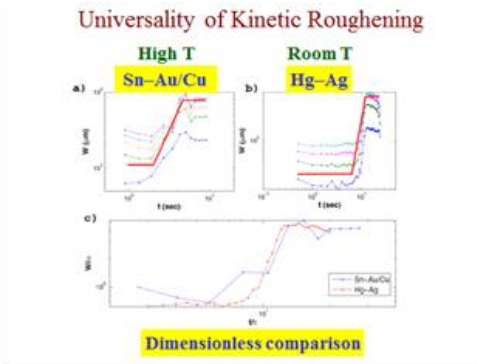

Fig. 4 *Universality of kinetic roughening: High temperature vs room temperature.*

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