Scilight

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# Surface tension and viscosity play significant roles in metal nanofilm heat destabilization

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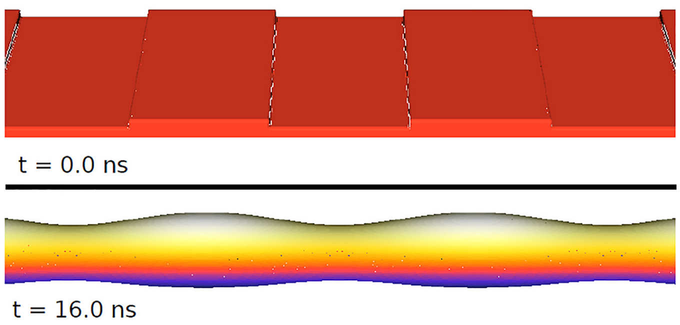
**Self-consistent simulations have started to unravel the mysteries of how heat affects the evolution of nanoscale metal films and filaments.**




Metal films of nanoscale thickness are of interest in numerous applications including solar cells and plasmonic sensing. To be used in a variety of ways, thin metal films must be formed to feature certain shapes, typically achieved through heating. Laser pulses are a common method of delivering heat to target areas. However, several forces, particularly between solid substrates and transient liquid films, pose to destabilize this evolution process. New research described in *Physics of Fluids* provides a better way to understand how heat affects the evolution of metal films and filaments on top of thermally conductive solid substrates.

These processes were thought to be significantly influenced by the Marangoni effect, a phenomenon in which the temperature dependence of surface tension causes surface stress that leads to fluid flow between films and substrates.

The authors of this work carefully modeled the intermittent melting and solidifying of the film as the materials were simulated to receive nanoseconds-long pulses of laser irradiation. Coupling fluid dynamics with spatio-temporal temperature changes in the film and the substrate, the authors were able to leverage Volume-of-Fluid-based models to find that the variation of surface tension and viscosity over time played significant roles in how these materials interacted. In particular, the influence of the temperature on surface tension is manifested through the capillary force. In other words, the thermal effects influence the interface evolution due to the time-dependent surface tension changes during a laser pulse.

The Marangoni effect was deemed insignificant in these circumstances and liquid-metal filament geometries were less sensitive to temperature. The researchers stated that they hope their work stokes further inquiry into the effects of substrate melting, the conditions required for non-monotonous oscillatory instability and the significance of these effects on multi-metal films and alloys.

**Source:** “Influence of thermal effects on stability of nanoscale films and filaments on thermally conductive substrates,” by Ivana Seric, Shahriar Afkhami, and Lou Kondic, *Physics of Fluids* (2018). The article can be accessed at https://doi.org/10.1063/1.5008899.