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Novel mechanisms for self-assembled pattern formation in nanoscopic metal films[1] R. KALYANARAMAN, J. TRICE, C. FAVAZZA, Department of Physics, Washington University in St. Louis, D. THOMAS, R. SURESHKUMAR, Department of Energy, Environmental and Chemical Engineering, Washington University in St. Louis — Classical hydrodynamic theory of dewetting of spinodally unstable thin films (*Vrij, Disc. farad. Soc. 1966*) predicts a monotonic increase in patterning length scales with increasing film thickness. We verified this effect for nanoscopic Co metal films following melting by ns laser pulses for thickness regime $h \leq h_c \sim 8\,nm$ (*Favazza et al. Nanotechnology, 2006*). However, a dramatic change is observed beyond this thickness h_c, with length scales decreasing with increasing h. This novel behavior arises from strong thickness dependence of heating by ultrafast laser light resulting in thermocapillary effects, whose magnitude and sign are thickness dependent. We modified the classical theory, according to which the instability occurs when the stabilizing capillary force is overcome by destabilizing attractive long-range interactions, to include thermocapillary effects. The modified theory accurately predicts the experimentally observed trend. This result suggests that a variety of new length scales can be accessed by robust self-assembly via dewetting of metal films under ultrafast light.

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Ramki Kalyanaraman
Department of Physics, Washington University in St. Louis

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