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Complex Pattern Formation from Current-Driven Dynamics of Single-Layer Epitaxial Islands on Crystalline Conducting Substrates[1]
ASHISH KUMAR, DWAIPAYAN DASGUPTA, DIMITRIOS MAROUDAS, Department of Chemical Engineering, University of Massachusetts, Amherst — We report a systematic study of complex pattern formation resulting from the driven dynamics of single-layer homoepitaxial islands on face-centered cubic (FCC) crystalline conducting substrate surfaces under the action of an externally applied electric field. The analysis is based on an experimentally validated nonlinear model of mass transport via island edge atomic diffusion, which also accounts for edge diffusional anisotropy. We analyze the morphological stability and simulate the field-driven evolution of rounded islands for an electric field oriented along the fast diffusion direction. For larger than critical island sizes on {110} and {100} FCC substrates, we show that multiple necking instabilities generate complex island patterns, including void-containing islands, mediated by sequences of breakup and coalescence events and distributed symmetrically with respect to the electric field direction. We analyze the dependence of the formed patterns on the original island size and on the duration of application of the external field. Starting from a single large rounded island, we characterize the evolution of the number of daughter islands and their average size and uniformity. The analysis reveals that the pattern formation kinetics follows a universal scaling relation.

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Ashish Kumar
Department of Chemical Engineering, University of Massachusetts, Amherst

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