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Electromigration-Driven Surface Morphological Stabilization of a Strained Thin Film on a Substrate GEORGIOS I. SFYRIS, M. RAUF GUNGOR, DIMITRIOS MAROUDAS, Department of Chemical Engineering, University of Massachusetts, Amherst, MA 01003 — This study investigates the surface morphological stability of a coherently strained, elastic and electrically conductive epitaxial thin film on a semi-infinite and on a finite deformable substrate. The film is subjected to an external electric field that drives surface electromigration but does not affect its elastic constants. Due to its lattice mismatch with the substrate, the film is in a state of biaxial strain that can cause surface morphological instabilities. We develop a three-dimensional, fully nonlinear continuum model that describes the surface morphological evolution of the film and carry out a linear stability analysis using a local approximation for the electric field. The resulting dispersion relation shows that, in certain cases, surface electromigration can inhibit the stress-induced instabilities. We report results of a systematic analysis that maps the surface morphological stability domain boundaries as a function of material properties, lattice-mismatch strain, film and substrate thicknesses, and electric-field strength.

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