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Inhibition of surface instabilities by combined action of electric fields and thermal gradients LIN DU, DWAIPAYAN DASGUPTA, GEORGIOS I. SFYRIS, DIMITRIOS MAROUDAS, Univ of Mass - Amherst — Surface instabilities, such as the Asaro-Tiller-Grinfeld (ATG) and the Stranski-Krastanow (SK) instabilities, originating due to the competition between surface free energy and elastic strain energy, pose serious reliability problems for device fabrication. Elastic strain energy is stored in bulk-like crystalline solids due to externally applied or process-induced stress and in epitaxial thin films on substrates due to the lattice mismatch between the film and substrate materials. We demonstrate that proper application of sufficiently strong external field(s) can eliminate ATG and SK instabilities based on linear stability analysis according to a fully nonlinear three-dimensional model of driven surface morphological evolution. We find that the simultaneous action of an electric field and a thermal gradient, in conjunction with substrate engineering, is capable of reducing the critical external field strength requirement by several orders of magnitude. We also derive the conditions for the synergy or competition between the two external fields toward surface stabilization. We validate the linear stability theory by comparisons of its predictions with results of self-consistent dynamical simulations of electrically and thermally driven surface evolution.

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