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Nonlinear Analysis of the Surface Morphological Stability of Stressed Crystalline Materials and Coherently Strained Epitaxial Thin Films LIN DU, DWAIPAYAN DASGUPTA, DIMITRIOS MAROUDAS, University of Massachusetts Amherst — The competition between surface energy and elastic strain energy in surfaces of stressed solids may cause the Asaro-Tiller/Grinfeld (ATG) instability leading to surface cracking, which can be predicted by linear stability theory (LST). Self-consistent dynamical simulations based on a fully nonlinear surface evolution model reveal that, in addition to the ATG instability, long-wavelength perturbations from the planar surface morphology can also trigger a tip-splitting instability, causing the formation of a pattern of secondary ripples that cannot be predicted by LST. We have developed a weakly nonlinear stability theory that can explain the occurrence of such nonlinear rippling instabilities and predict the critical wavelength for secondary ripple formation as well as the number of secondary ripples that form on the surface as a function of perturbation wavelength. We also have applied the weakly nonlinear theory to study the surface morphological stability of a coherently strained epitaxial thin film on a crystalline elastic substrate. We find that, in addition to the Stranski-Krastanow instability, secondary rippling instabilities may also occur on the film surface, leading to formation of smaller-sized quantum dots (QDs) through tip splitting of larger QDs.

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