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Theory of multiple quantum dot formation in strained-layer heteroepitaxy DIMITRIOS MAROUDAS, LIN DU, University of Massachusetts Amherst — We develop a morphological stability theory that explains the experimentally observed formation of multiple quantum dots (QDs) in strained-layer heteroepitaxy. Using a fully nonlinear model of surface morphological evolution that accounts for a substrate wetting potential as well as surface diffusional anisotropy, we demonstrate the formation of multiple QD patterns in self-consistent dynamical simulations of the evolution of the epitaxial film surface perturbed from its planar state. The simulation predictions are supported by weakly nonlinear analysis of the epitaxial film surface morphological stability. We find that, in addition to the Stranski-Krastanow instability, long-wavelength perturbations from the planar film surface morphology can trigger a nonlinear instability, resulting in the splitting of a single QD into multiple QDs of smaller sizes, and predict the critical wavelength of the film surface perturbation for the onset of the nonlinear tip-splitting instability. The theory provides a fundamental interpretation for the observations of QD pairs or double QDs and other multiple QDs reported in experimental studies of epitaxial growth of semiconductor strained layers on patterned and unpatterned substrates.

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