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Composition Maps in Strained Alloy Quantum Dots NIKHIL MEDHEKAR, VISHWANATH HEGADEKATTE, VIVEK SHENOY, Brown University
— Knowledge of composition profiles within self-assembled SiGe and InGaAs quantum dots is critical for applications in optoelectronic and memory devices as variations in composition at the nanoscale can substantially influence their electronic properties. Obtaining the quantitative description of composition profiles in the quantum dot is a challenging task due to the coupling between composition variations, shape of the quantum dots and long-range elastic interactions. In this talk, we present an efficient scheme that combines the finite element analysis with an optimization scheme based on a quadratic programming method to determine equilibrium profiles in strained quantum dots. Composition profiles are found to strongly depend on the shape of the quantum dots, as strain relaxation in dots with steeper sidewalls allows for segregation of the larger alloy component in the regions near the apex. Based on these observations, we have developed a phase diagram that shows the degree of segregation of the alloy components in the phase space spanned by the temperature (which governs chemical mixing) and the shape of the dot. Further, we find that the segregation of the alloy components can substantially reduce the critical dot size for the transition between the shapes with different facets.

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