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Abstract

Self-organization of heteroepitaxial islands deposited over a substrate

By

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Fabrication of regular nanostructures has been investigated for over a decade with modest progress. Although there are varieties of method for fabricating nanostructures but very few of them are cost effective and less time consuming. One of the commonly used methods is to use the concept of self-organization which draws attention of researchers over past few years. The proposed work focus on the fabrication of nanostructures by using self-organization for the arrangement of strained epitaxial islands deposited over a substrate. In isotropic condition and defect free substrate deposited islands repel each other and results into formation of hexagonal domain which meet at defects. Goal is to use the anisotropy to organize the islands such that the defect develops in isotropic case get reduced. Focus is on in-plane anisotropies in surface stress and lattice mismatch between the film and substrate materials. Starting from a configuration where island sizes and position are random, evolution towards equilibrium through mass transport via condensation/evaporation is simulated. An efficient numerical method is obtained by reducing a model of square monolayer islands of finite size to point dipole that interact through their elastic fields. Models for both the kinetics and energetics of the system are obtained by this reduction. It is found that the point source model is accurate for island separations larger than about 3 times the width of an island. Anisotropy introduces orientational preferences which enhance organization in cases of modest anisotropy and cause islands to form into zigzagged lines in cases of high anisotropy. To get control over the position of islands some defects in the form of dislocation is introduced into the substrate. It is found that the dislocations field modulates the elastic field of the system and hence induces the preferred locations for islands. The effect of topographically patterned substrate is also studied. Pattern used in this work is raised square-shaped mesa. The islands deposited atop a raised mesa interact with the mesa and arrange into low energy or stable configuration. Through the analysis of the elastic interaction between mesa and islands some preferred positions of islands is obtained.

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