USING STRAIN TO DESIGN NANOSTRUCTURES

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Conditions that determine the morphology of thin films have been the subject of considerable study. The technological implications are significant: the ability to synthesize planar films and to control the thickness at the level of a monolayer promises a whole new generation of nanoscale structures. As devices become smaller, nanostructures become their necessary building blocks, exhibiting novel electronic and optical properties. Most of the work to date has focused on the development of films for semiconductor devices. The fairly recent observations of self-organizing nanostructures have added another exciting angle to the investigation of thin-film deposition. Self-assembly has attracted a lot of interest and a considerable number of studies have demonstrated and, to some degree modeled, the physics underlying the phenomenon. They have not, however, provided any simple mechanism for tailoring growth. The work described in this presentation has the potential to do exactly that: allow for a simple, inexpensive way of controlling the size and location of nanostructures.

Experimental results suggest that surface stress exhibits a strong nonlinear dependence on adatom coverage. In a recent manuscript submitted to the *Journal of Mechanics and Physics of Solids*, a rigorous analysis illustrates for the first time that the nonlinear behavior is related to a dependence of adatom interaction energy on strain. Strong strain strain dependence is evident, even when adatoms are far apart. We found that the dipole characterizing an adatom may change with applied strain, strain induced by other defects, and interaction with boundaries. The analysis yields a simple relation between surface stress and level of adatom coverage during deposition that is striking similar to experimental observations. The constitutive constants of an adatom are obtained using a simple atomistic calculation that is based on energy considerations. What makes this discovery significant is that it has the potential of providing an inexpensive mechanism for design and fabrication of nanostructures.