Abstract for an Invited Paper
for the MAR12 Meeting of
The American Physical Society

Making Novel Materials Using Strain in Nanomembranes[1]

MAX G. LAGALLY, University of Wisconsin-Madison, Madison WI 53706

The controlled introduction of strain in materials offers an important degree of freedom for fundamental studies of materials as well as advanced device engineering. Strain in a crystalline solid modifies the lattice constants and reduces the crystal symmetry. Because strain energy is proportional to thickness, a free-standing crystalline thin sheet, which we call a nanomembrane (NM), can be strained to a greater degree that a bulk material with the same surface area. I show the use of nanomembrane strain engineering to make defect-free single crystals that cannot be grown any other way, and materials with strain symmetries that they do not have naturally, in both cases alloys of Si and Ge. Strain in NMs causes significant shifts in energy band edges, splitting of degenerate states, and changes in effective masses. These effects can be used to produce a desired band offset between different materials, to increase carrier mobility, and to change relative energy positions of valleys. In the latter respect, through the use of NMs it has recently become possible, using tensile strain, to make Ge direct-bandgap and light emitting at room temperature. Periodic local stress can produce strain superlattices and thus single-element heterojunctions. Work performed with the Roberto Paiella, Mark Eriksson, Feng Liu, and Irena Knezevic research groups.

[1]Support provided patially by DOE, AFOSR, and NSF