MAR08-2007-020175

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Silicon Nanomembranes[1]

MAX G. LAGALLY, University of Wisconsins-Madison

Silicon nanomembranes (SiNMs) are extremely flexible, strain-engineered, defect-free, thin single-crystal sheets, with thicknesses from several 100 nm to less than 10 nm. Their novelty is several-fold: they are flexible, they are readily transferable to other hosts and conform and bond easily, they are stackable, and they can take on a large range of shapes (tubes, spirals, ribbons, wires) by engineering the strain and patterning the geometry. One can thus think of SiNMs as having inexact and tunable dimensionality, from 3-D to 0-D (when growth of quantum dots is included). Many properties of bulk Si are modified by thinness, strain, shape, and size, including band structure and quantum properties, electronic transport, phonon distributions, and mechanical properties. Because they are so close, the two surfaces of the membrane can influence each other's behavior, and the surface also becomes a significant influence on overall SiNM properties. After a review of SiNM fabrication, strain engineering, and transfer, we overview some of the unexpected physical and electronic properties of SiNMs. These include surface transfer doping via surface structures or adsorbed layers, through-membrane elastic interactions to create periodic strain lattices, energy level splitting and shifting with strain and quantum size effects, and orientation-dependent mobility enhancement with strain. SiNMs provide the potential for new or enhanced application of Si in fast flexible electronics; quantum electronics, new nanophotonic, optoelectronic, and thermoelectric devices; and chemical and biological sensors. These applications will be briefly outlined.

[1]Research supported by DOE, AFOSR, and NSF.