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Raman Spectroscopy and Strain Mapping in Individual Ge- Si_xGe_{1-x} Core-Shell Nanowires[1]

DAVID DILLEN, KAMRAN VARAHRAMYAN, EMANUEL TUTUC, University of Texas at Austin — Core-shell Ge-Si_xGe_{1-x} nanowires (NWs) are expected to contain large strain fields due to the lattice-mismatch at the core/shell interface. Here we report measurement of the core strain in such NW heterostructures by Raman Spectroscopy. We measure the diameter dependence of Raman spectra in individual Ge NWs, as well as Ge-Si_xGe_{1-x} core-shell NW heterostructures. We find that the bare Ge NWs show no diameter-dependence of the Ge-Ge peak at 300.5 cm^{-1}. On the other hand, the Ge-Ge peak of the Ge-Si_xGe_{1-x} core-shell NW shows a blue shift by comparison to the bare Ge NWs. This blue shift increases with reducing the NW diameter as a result of larger compressive strain in the Ge core. While the elastic strain is expected to split the triply degenerate Ge-Ge mode into separate singlet and doublet peaks, only the singlet mode was observed in experiment, a finding explained by the NW absorption and emission anisotropy. Using lattice dynamical theory and the Raman spectroscopy results we determine the strain in Ge-Si_xGe_{1-x} core-shell NWs as a function of the NW diameter. We compare the experimental results with the strain values calculated using a continuum elasticity model.

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