Nanocomposites and nanomaterials

Photocurrent spectroscopy of Ge nanoclusters grown on oxidized silicon surface

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Germanium nanoclusters grown on/in silicon or silicon dioxide have been successfully applied in new nanoelectronic, optoelectronic, and memory devices due to the quantum confinement effect and the possibility of integration within the Si-based technology [1]. Heterostructures with epitaxial Ge nanoclusters isolated from the Si substrate by an ultrathin silicon oxide layer would be practically promising due to their nanoscale size, tunability, and high density. The interest in the optoelectronic and solar cells application stems from the observation of infrared photoluminescence and photoconductivity caused by optical transitions through confined states of Ge nanoislands.

X-ray diffraction and photocurrent spectroscopy demonstrate that the nanoclusters have the local structure of body-centred tetragonal Ge, which exhibit an optical absorption edge at 0.48 eV [2,3]. The usual diamond-like crystal structure of Ge nanoclusters appears to be completely absent due to isolation from Si(100) substrate.

Optically induced changes of persistent conductivity in structures with Ge NCs grown on silicon oxide are observed at low temperatures. Selective excitation of Ge-NCs or Si by photons with different energy results in recharging of interface and NC's states leading to local-field effect on surface conductivity of underlying Si. Intrinsic absorption in Si at low temperatures induces residual conductivity due to reducing of downward band bending as a result of decreasing of positive charge trapped by NC's and SiO_2/Si interface.

Infrared illumination in the range from 0.6 eV to 1.0 eV results in selective photoexcitation of Ge NCs, trapping of excess holes by NCs and interface states, and observation persistent conductivity lower than equilibrium value.

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