Nanocomposites and nanomaterials

Local trapping and recombination of charge carriers in heterostructures with Ge nanoclusters

A.O. Mykytiuk[1,2], S.V. Kondratenko[1], V.S. Lysenko[3]

[1] *Taras Shevchenko National University of Kyiv, 64/13 Volodymyrska Str., 01601, Kyiv, Ukraine*
E-mail: mykytiuk_nastya@ukr.net

[2] *State enterprise of a special instrumentation "Arsenal", 8, Moskovska Street, 01010, Kyiv, Ukraine*

[3] *Institute of Semiconductor Physics, 41 Prospect Nauki, 03028, Kyiv, Ukraine*

The understanding of local charge trapping on the nanoscale is crucial for the design of novel electronic devices and photodetectors based on SiGe nanoclusters.

Kelvin probe force microscopy was used for the detection of charge trapping and recombination in Ge nanoclusers. The observation of a surface potential distribution with maxima at the Ge NC location and lowest values at the NC's surrounding is indicative for trapping of positive charges within the NCs. A clear linear decrease of the potential from the top of the Ge NCs to their bases is observed. This manifests that the number of holes stored in the individual Ge NCs is higher as compared to holes captured by other traps of the substrate surface.

Electrons and/or holes were injected into the isolated Ge NC on top of the Si layer using a conductive AFM tip. After charging of a single nanocluster, significant changes in the surface potential and charge redistribution were observed. After electron injection, the CPD map exhibits higher contrast due to electron-hole recombination and a decrease of positive charges trapped by Ge NCs and surface states. On the other hand, holes injected into a single Ge nanocluster could spread out into the surrounding region when biasing of the *n*-tip/*i*-Ge NC/*p*-Si junction in the opposite direction. As a consequence, the CPD map exhibits the highest value and becomes practically equipotential between the NC and the surrounding.

The observed temporal evolution of the CPD map confirms the ability of NCs to retain the holes during a long time after injection.

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