13/06/2014 Nano Werk

Researchers generate high electron mobility gases in semiconductor nanowires for the first time

(Nanowerk News) Nanotechnology, optics and photovoltaic energy are among the fields that can benefit from advances in knowledge on semiconductor nanowire systems. Researchers at the Universitat Jaume I in Castelló (UJI), the Consiglio Nazionale delle Ricerche in Italy and the Walter Schottky Institut in Germany have succeeded to prove, for the first time, the accumulation of high electron mobility gases in multilayer nanowires from a technique called "remote doping".

This technique, which is currently being used as standard in industry, has allowed for more than 35 years to obtain high electron mobility devices typically based on multilayer planar structures. Research published in the journal Nano Letters ("Unintentional High-Density p-Type Modulation Doping of a GaAs/AlAs Core–Multishell Nanowire") collects for the first time the obtaining of these high mobility electrons in an entirely new morphology, such as gallium arsenide nanowires, a hexagonal tube at nanoscale growing on a silicon surface and radially coated with other semiconductor materials.

This unique multilayer structure can create spaces in nanowires where electrons move free of impurities at high speed. In this sense, Miquel Royo, researcher at the Quantum Chemistry Group at the UJI, stresses that they have achieved "the highest electron mobility in semiconductor nanowires that has been published to date".

The study showed that the experimental measurements performed by German researchers on doped nanowires are consistent with computer simulations carried out by the researcher at the UJI, in which the existence of a high electron mobility gas in the nanowire is assumed.

Theoretical simulations of the system have also led to the conclusion that "the resulting electron gas has a mixed dimensionality. The electrons tend to be located at the interfaces between the different layers of the nanowire, which gives them a two-dimensional character. However, due to the peculiar hexagonal shape of the nanowires and the repulsion between the electrons, it has been observed that these are accumulated predominantly at the vertex of the heterostructure, thus forming unidimensional channels.

Without needing doping elements

The journal Nano Letters ("High Mobility One- and Two-Dimensional Electron Systems in Nanowire-Based Quantum Heterostructures") recently published a new study by the same researcher at the Quantum Chemistry Group at the UJI in collaboration with researchers from

the Laboratoire National des Champs Mannétiques Intenses in Toulouse (France). In this study, they have managed to generate again electronic gases in multilayer nanowires, but this time without requiring the introduction of doping elements intentionally.

The study shows that a thin layer of gallium arsenide grown on the nanowire between two aluminum arsenide layers acts as a trap for the carbon atoms that are present in all growth chamber. “The carbon accumulated in the nanowire acts, in turn, as a dopant that has not been intentionally added, and it creates the appearance, in this case, of an electron hole gas”, explains Royo, noting that “in this way, we get an alternative technique for obtaining electronic gases in this complex technical systems”. The verification of the presence of electron hole gas in the nanowires was carried out by confronting experimental measurements of photoluminescence with computer simulations performed by the same researcher at the UJI.

The results presented in both publications represent important technological advances, especially in the field of nanoelectronics, “that is particularly useful to have nanodevices in which the mobility of electrons is so high, especially for high frequency applications such as mobile phones that require that you have a low power dissipation”, says the researcher at the Universitat Jaume I. He adds that “once we are able to reproducibly grow this new type of semiconductor nanostructures, they will represent an ideal scenario to study the fundamental properties of high mobility electronic gases in new mixed dimensionality morphologies”.

Source: Asociación RUVID

Read more: Researchers generate high electron mobility gases in semiconductor nanowires for the first time http://www.nanowerk.com/nanotechnology-news/newsid=36032.php#ixzz34mMJlVqT