

9th Nano Congress for Next Generation

August 01-02, 2016 Manchester, UK

Geometry induced doping in thin si nano-grating layers

M Mebonia^{1,3}, A Tavkhelidze¹, L Jangidze², G Skhiliadze², D Ursutiu⁴, C Samoila⁴, Z Taliashvili² and L Nadaraia⁵

¹Ilia State University, Georgia

²Institute of Micro and Nano Electronics, Georgia

³Peter Grünberg Institut PGI, Germany

⁴Transilvania University of Brasov, Romania

⁵Georgian Technical University, Georgia

Recently, new quantum features have been studied in the area of nanostructured layers. Nano-grating on the surface of the thin layer imposes additional boundary conditions on the electron wave function and induces G-doping or geometry doping. G-doping is equivalent to donor doping from the point of view of the increase in electron concentration 'n'. However, there are no ionized impurities. This preserves charge carrier scattering to the intrinsic semiconductor level and increases carrier mobility with respect to the conventionally doped layer. We fabricated Si nano-grating layers and measured their electrical characteristics to monitor geometry induced doping (G-doping). Grating was fabricated using laser interference lithography (375 nm laser) followed by reactive ion etching of Si. Next, large square island (0.3 x 0.3 mm) was shaped in the device layer and four Si\Ti\Ag ohmic contacts were formed to measure electrical characteristics. The I-V characteristics were recorded using both 4 wire and 2 wire methods. Resistance-temperatureure $\rho(T)$ dependences ($T = 300$ K) were recorded as well. For all 12 samples, nano-grating layers showed 2-3 order of magnitude reduction in resistivity. Resistivity anisotropy was in the range 0.2-1 at 300 K. Obtained geometry induced doping level corresponds to "effective impurity" concentration of 3×10^{18} cm⁻³. The agreement with G-doping theory, $\rho(T)$ dependence, is that it was observed (data from 12 samples) that nano-grating reduces resistivity of Si layer from ≈ 10 Ohm cm (plain layer) to 5×10^{-2} - 8×10^{-3} Ohm cm. This reduction is in agreement with theoretical prediction of G-doping. Value 10^{-2} Ohm cm corresponds to "impurity" concentration of 3×10^{18} cm⁻³ (Phosphorous in Si). G-doping does not requires ionized impurities. This allows high carrier mobility and temperature independent carrier concentration. Nano-grating fabrication does not require sophisticated technology and can be used for solar cells and other photovoltaic devices, ultra high frequency electronics and power electronics.

Biography

Mikheil Mebonia has completed his Master's from Ilia State University and started his PhD at the same university collaborating with RWTH Aachen University. Since 2014, he has been working in Juelich and Fraunhofer Institute of Laser Technology as a PhD Researcher. He is working in Scientific and Technological Centre "Nano Structured Materials for Renewable Energy" the School of Engineering in Ilia State University. He has published some papers in reputed journals.

m.mebonia@fz-juelich.de

Notes: