Fritz-Haber-Institut der Max-Planck-Gesellschaft

Physikalische Chemie — Direktor: Prof. Dr. Martin Wolf

MAX-PLANCK-GESELLSCHAFT

Department Seminar:

Monday, July 1, 2019, at **11:00** a.m.;
— all are invited to meet at around 10:40 for a chat with coffee & cookies —

Dr. Leila Balaghi Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf.

Two dimensional electron gas in core/multi-shell nanowires: focus on strain-engineered nanowires

PC Seminar Room G2.06, Building G, Faradayweg 4 A. Paarmann

Abstract:

III-V compound semiconductors have fueled many breakthroughs in physics and technology owing to their direct band gap and high electron mobility. GaAs is one of the well-known materials, especially for the extremely high mobility of electrons inside a two dimensional electron gas (2DEG) system. Here we designed GaAs core/$In_xGa_{1-x}As$ ($In_xAl_{1-x}As$) multi-shell nanowires as a 2DEG system. However, the important issue of the large lattice-mismatch between the GaAs core with the shell needs to be addressed. Therefore we explore strain engineering in core/shell nanowires. We demonstrate that the thin GaAs core (22 nm) in GaAs/$In_xGa_{1-x}As$ or GaAs/ $In_xAl_{1-x}As$ core/shell nanowires can sustain unusually large misfit strains that would have been impossible in equivalent thin-film heterostructures, and undergoes a significant modification of its electronic properties. Beyond a critical shell thickness, we obtain a heavily tensile-strained core and an almost strain-free shell. The tensile strain of the core exhibits a predominantly-hydrostatic character and causes the reduction of the GaAs band gap up to 40%. The reduced effective mass of electrons in the tensile-strained core of GaAs/$In_xAl_{1-x}As$ nanowires was calculated and the corresponding electron mobility was measured by optical-pump terahertz-probe spectroscopy which is in the range of 5200 cm2/V·s at 300 K. These mobility values are the highest reported, even beyond strain-free bulk GaAs and GaAs/$Al_xGa_{1-x}As$ nanowires. Finally, the strain-engineered GaAs nanowires brings on another degree of freedom to the initial 2DEG design, which is very intriguing for extremely high mobility structures especially in nano-electronics.

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