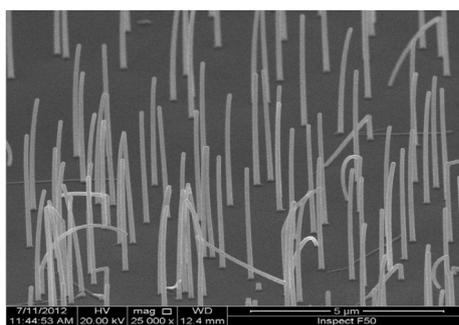


GaP/ZnO core-shell heterojunction nanowires

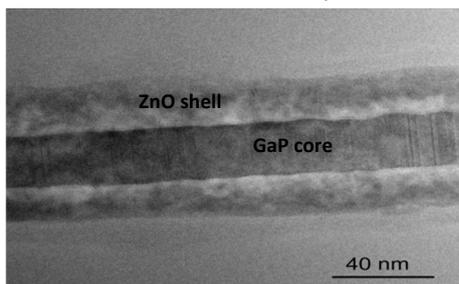
Core-shell nanowire (NW) heterostructures are very promising for applications in electronic and photonic devices such as field-effect transistors, solar cells and sensors. A core-shell NW usually consists of a low band gap core and a higher band gap shell. This leads to spatially direct transitions between electrons and holes. The shell protects the active core-shell interface. The band gap structure (for appropriate material combinations) is designed so as to extend the spectral sensitivity.

We studied p-GaP/n-ZnO core-shell NWs with radial pn heterojunction. The core-shell NWs were prepared in a two-step process: (1) GaP NWs were grown by MOVPE on p-type GaP (111)B substrate at 30 nm gold seed particles using a vapour-liquid-solid (VLS) technique, (2) the GaP NWs were covered with a thin nanocrystalline Ga-doped ZnO layer by RF sputtering. The GaP cores were conic ($\varnothing \sim 80$ nm at the substrate and 30 nm under the seeds) but the core-shell NWs were cylindrical ($\varnothing \sim 200$ nm). The core-shell NWs were 5 μm long. The deposition of the ZnO layers on the GaP NWs was very uniform: ZnO nanocrystallites fully covered the GaP NW surface from top to bottom. The nanocrystalline shell material presumably alleviated the structural incompatibility between zinc-blende structure of GaP and the wurtzite structure of ZnO.

The measured spectral sensitivity range of GaP NWs lies between 520 and 700 nm and that the ZnO shells extend that range of core-shell GaP/ZnO to the UV region (350 – 480 nm). Electrical contacts were processed to individual GaP/ZnO NWs using electron beam lithography, evaporation and lift-off of metallic layers: Au/Zn (p-type GaP core) and Au/Al (n-type ZnO shell). The radial pn junction of the NWs exhibited a rectifying diode-like behaviour with a relatively high on-voltage of 2.5 V. The open circuit voltage V_{oc} was ~ 2.45 V under illumination with white light obtained from solar simulator.



SEM view on GaP NWs covered by ZnO shell.



TEM view on core-shell structure of GaP/ZnO NWs.

Further information:

Novák, J, et al.: [Preparation of thin Ga-doped ZnO layers for core-shell GaP/ZnO nanowires](#). Applied Surface Sci 258 (2012) 7607-7611.

Novák, J., et al.: [Structural and optical properties of individual GaP/ZnO core-shell nanowires](#). Vacuum 98 (2013) 106-110.

Hasenöhrl, S, et al.: [Zinc-doped gallium phosphide nanowires for photovoltaic structures](#). Applied Surface Sci 269 (2013) 72-76.

Laurenčíková, A., et al.: [Analysis of the core-shell interface between zinc-blende GaP and wurtzite ZnO](#). Solid-State Electr. 100 (2014) 7-10.

Novák, J., et al.: [Columnar microstructure of the ZnO shell layer deposited on the GaP nanowires](#). Applied Surface Sci 312 (2014) 162-166.