Radial nanowire light-emitting diodes in the (AlxGa1-x)yIn1-yP material system

Berg, A.; Yazdi, Sadegh; Nowzari, A.; Storm, K.; Wagner, Jakob Birkedal; Jain, V.; Vainorius, N.

Publication date: 2016

Document Version
Peer reviewed version

Link back to DTU Orbit

Citation (APA):
Radial nanowire light-emitting diodes in the (Al<sub>x</sub>Ga<sub>1-x</sub>)<sub>y</sub>In<sub>1-y</sub>P material system

A. Berg, S. Yazdi, A. Nowzari, K. Storm, V. Jain, N. Vainorius, L. Samuelson, J. B. Wagner and M. T. Borgström

1 Solid State Physics, Lund University, Box 118, SE-221 00, Lund, Sweden
2 Center for Electron Nanoscopy, Technical University of Denmark, DK 2800 Kgs. Lyngby, Denmark
3 Department of Materials Science and NanoEngineering, Rice University, 6100 Main Street MS-325, Houston, TX 77005, United States
4 Laboratory of Mathematics, Physics and Electrical Engineering, Halmstad University, Box 823, SE-301 18 Halmstad, Sweden

We present a growth scheme for radial nanowire (NW) quantum-well pin-junction structures in the AlGaNnP material system. The different layers were analyzed by XRD with respect to lattice-matching and the structural properties evaluated by STEM-EDX. We find Al segregation in the corners of the AlGaNnP shells and Ga enrichment in the corners of the GaInP layers. After vertical NW processing, we measured the electro-optical properties of the NWs and the LED devices illuminated with red color at a forward bias of about 3 V.

Radial nanowires could play an important role for next-generation light-emitting diodes because the NW core can be used as a “substrate” and shells can be grown with the desired optical wavelength. Here, we use the AlGaNnP material system which is suitable for long-wavelength visible emission. Ternary GaInP acts as active layer for light emission and AlGaNnP as charge carrier barriers.

By use of metal-organic chemical vapor deposition (MOCVD), the p-type GaInP NW core was grown with homogeneous material composition from a regular pattern defined by nanoimprint lithography [1]. Several shells were grown lattice-matched to the NW core with composition leading to red luminescence. STEM-EDX measurements show Al enrichment in the corners and we conclude that Al tends to segregate towards the vertices of the hexagon. Electrical injection luminescence (IL) measurements show a peak at around 1.85 eV while the peak does not shift with increasing current [2].

![Al, Ga, In and P maps](image)

![IL measurements](image)

Fig. 1. Left: Al, Ga, In and P maps measured using STEM-EDX elemental mapping on GaInP/AlGaNnP/GaInP core-shell NWs. Right: IL measurements with different currents.

References
