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Publication date:
2016

Document Version
Peer reviewed version

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Citation (APA):
Berg, A., Yazdi, S., Nowzari, A., Storm, K., Wagner, J. B., Jain, V., & Vainorius, N. (2016). Radial nanowire light-emitting diodes in the (AlxGa1-x)yIn1-yP material system. Abstract from 18th International Conference on Crystal Growth and Epitaxy, Nagoya, Japan.

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Radial nanowire light-emitting diodes in the $(Al_xGa_{1-x})_yIn_{1-y}P$ material system

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We present a growth scheme for radial nanowire (NW) quantum-well pin-junction structures in the AlGaInP 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 AlGaInP 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 AlGaInP material system which is suitable for long-wavelength visible emission. Ternary GaInP acts as active layer for light emission and AlGaInP 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].

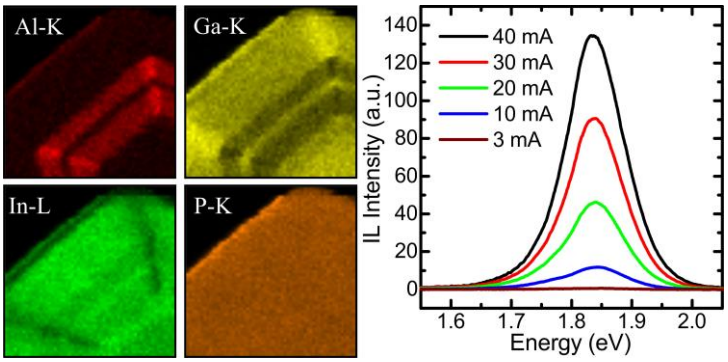

Fig. 1. Left: Al, Ga, In and P maps measured using STEM-EDX elemental mapping on GaInP/AlGaInP/GaInP core-shell NWs. Right: IL measurements with different currents.

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