Nanoscale physics

MBE-grown wurtzite GaAs-(Ga,Al)As-Ga(As,Bi) core-shell nanowires: structure and optical properties

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All-wurtzite nanowires (NWs) composed of GaAs NW cores, (Ga,Al)As inner and Ga(As,Bi) outer shells were grown by molecular beam epitaxy (MBE) on GaAs(111)B substrates. Thin gold droplets, predeposited on GaAs(111)B were used as NWs growth catalysts. Well-selected MBE growth conditions enabled the growth of NWs with hexagonal (wurtzite) structure, which does not occur in bulk crystals and epitaxial layers of this material. Alloying GaAs with Bi results in a semiconductor with interesting optical properties, due to the important band-gap reduction and enhancement of the spin-orbit splitting in Ga(As,Bi). Both features make this alloy interesting for optoelectronic applications in near-infrared energy range, and suitable for solar cell applications. The maximum Bi content in uniform Ga(As,Bi) crystal reported so far reaches about 10%. Attempts to obtain higher composition of Ga(As,Bi) solid solution lead to Bi segregation. For the Ga(As,Bi) NW shells grown at the highest Bi/As flux ratio we have observed segregation of Bi nanodroplets at the NW side-walls. These nanodroplets act as catalysts for the growth of NW branches, perpendicular to main GaAs NW trunks, hence they can be used for branched NW growth. The structural properties of NWs have been characterized by scanning and transmission electron microscopy, optical properties by cathodoluminescence, photoluminescence and Raman scattering methods.

This work was partially supported by the National Science Centre (Poland) under projects UMO-2012/07/B/ST5/02080 and UMO-2014/13/B/ST3/04489.