Crystal structure and optical characterization of radial heterostructured GaAs/AlGaAs/GaAs nanowires

F.E.G.Guimarães, R. A. Caface, H.Arakaki, C.A. de Souza, and Yu.A.Pusep

Instituto de Fisica de São Carlos, Universidade de São Paulo, 13560-970 Sao Carlos, SP, Brazil

Structural and optical properties of heterostructured GaAs/AlGaAs/GaAs core/inner shell/outer shell NWs are studied. Transmittance electron microscopy, CW and time-resolved photoluminescence as well as Raman scattering measurements unambiguously manifest to the presence of segments crystallized in zinc-blende and wurtzite phases, which spread to the shells. The effect of in-built electric field is to energetically separate optical transitions due to recombination of spatially separated electron-hole pairs. Four observed photoluminescence lines are assigned to the radiative recombination of photoexcited electrons confined in the center of the GaAs core and at the heteroboundary between the outer GaAs shell and the inner AlGaAs one with the holes localized at the heteroboundary between the core and the inner AlGaAs shell; both recombinations take place in zinc-blende and wurtzite phases. One additional photoluminescence line is attributed to the spatially indirect recombination between the electrons in zinc-blende and the holes in wurtzite phases. Band gap of the wurtzite phase and the band offsets between the zinc-blend and wurtzite structures are determined. A simple model, based on representation of the valence band structure using two levels, accounts well for the observed temperature dependence of the integrated photoluminescence intensities. The proposed double shell structure with tunneling transparent inner shell sets conditions for easy control of the emission energy of the heterostructured nanowires. In addition, time-resolved photoluminescence was employed to study electron-hole dynamics in radial heterostructured GaAs/AlGaAs/GaAs core/inner shell/outer shell nanowires. It was found that impurity random potential produces a red shift of the decay time maximum with respect to the photoluminescence peak energy. The results of this study are partially published in [1].

[1] F.E.G.Guimarães, R. A. Caface, H.Arakaki, C.A. de Souza, and Yu.A.Pusep, J.Appl.Phys. **113**, 064315 (2013).