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We studied the initial state of VLS-growth of InAs nanorods onto GaAs[111]B via Au catalyst at growth temperature of 450℃ where the growth was truncated after 20s, 40s, 60s and 300s, respectively. The whole samples have been analyzed at room temperature using out-of plane high-resolution x-ray diffraction in home laboratory and in-plane depth-resolved x-ray grazing-incidence diffraction (GID) with synchrotron radiation. Selected NRs have been inspected by TEM as well. Samples with growth time of 20s and 40s did not show InAs NRs. Instead we identified several Indium rich Au phases at the surface and a strongly enhanced diffuse scattering in vicinity of the GaAs peaks. InAs NRs appeared after 60s growth time crystallized in wurzite phase. At same time small $In_{1-x}Ga_xAs$ components with composition ranging between x=0.05 and 0.22 were observed grown with zinc-blende structure accompanied with large diffuse scattering close to the GaAs. Depth-resolved GID and HR-TEM showed that the $In_{1-x}Ga_xAs$ components are located at the basement of NRs. Additionally we found alloy clusters buried under truncated NRs. Our data suggest a model where InAs NRs grow out of an Indium enriched Au-Ga phase. However, inclusion of indium into Au-Ga (T_e=339℃) first decreases the melting point of Au-Ga-In eutecticum, but for higher Indium content the eutectic melting temperature increases up to 454 ℃ valid for the Au-In system. For a growth temperature between 350℃ and 460℃ Au alloy droplets remain liquid since the gallium concentration exceeds about 30 to 0 at%, respectively. Therefore Au droplets with low gallium content become solid and cannot act as catalyst anymore. Hence, stable NR growth can be established only if the metallic alloy droplet contains a sufficient concentration of gallium.

Keywords: growth mechanisms, nanocrystals, high-resolution X-ray diffraction

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InGaP/GaAs(001) structural characterization by means of synchrotron radiation Renninger Scan

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Synchrotron radiation Renninger Scan (RS), a high resolution structural probe, is applied in the layer and the substrate simultaneous characterization of the InGaP/GaAs(001) epitaxial structures. Around $\phi = 0^o$ symmetry mirror of the RS, Bragg-Surface reflections (BSD) which are secondary beams propagating along the surface/interface which provide the strain distribution in the layer/substrate interface and around $\phi = 45^o$ the coherent hybrid reflections (CHR) [Morelhão et al, Appl. Phys. Lett., 73(15), 2194 (1998)] allow for the simultaneous characterization of layer and substrate lattices. InGaP layers with composition variation into [1 0 0] and [0 1 0] directions were grown on GaAs(001) by Chemical Beam Epitaxy (CBE). Several (002) rocking curves were measured and plotted as pole figures around [0 0 1] direction to evidence the occurrence of (1 -1 3)(1 -1 -1) CHR. Entrance and exit positions of (1 -1 1), (1 1 1), (-1 -1 1) and (-1 1 1) BSD reflections in the (002) RS of both GaAs and InGaP lattices carried out in the Brazilian synchrotron (LNLS) allowed to figure out the strain in-plane [Morelhão et al, Phys. Stat. Sol (a), 8, 2548 (2007)] along the [1 1 0] and [1 -1 0] directions. The layer value (25.1(4) $x10^{-4}$) is one order of magnitude greater than the substrate value (1.3(4) $x10^{-4}$) as expected since the layer has a composition variation. (0 -2 2)(0 2 2) and (-2 0 2)(2 0 2) four-beam reflections measured as a negative peak in the (004) substrate RS at $\phi = 45^o$ and 135^o, respectively. Each peak has turned into two three-beam reflections in the layer RS due to the structural tetragonal distortion ($a = b$ = 5.6539 Å and c = 5.6872 Å obtained from RS simulation). Financial support: CAPES, CNPq and FAPESP.

Keywords: semiconductor epitaxy, X-ray multiple diffraction, strain determination

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High resolution X-ray diffraction study of $Al_xGa_{1-x}Sb$ alloys grown by liquid phase epitaxy

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AlxGa1-xSb epitaxial layers were grown by liquid phase epitaxy at 400 ℃ on (001) and (111) undoped GaSb substrates. The layer composition was measured by energy dispersive x-ray spectroscopy, obtaining composition values between x=0.05 and x=0.36 of Al content. High resolution x-ray diffraction profiles were obtained from the (004) and (444) reflections respectively. In both cases the relative lattice mismatch was of the order of 10^{-3}. From the rocking curves was obtained the out of plane lattice parameter, directly from the symmetrical diffractions for (001) and (111) alloys. It was determined that all the layers are strained, and those grown on (001) GaSb are slightly more strained than the corresponding layers grown on (111) GaSb. This difference is explained by the dependence of the strain ratio on growth direction [1, 2]. The out of plane lattice parameter as a function of Al content is higher than the corresponding bulk lattice parameter of AlxGa1-xSb layers obtained with Vegard's law. Also, the perpendicular lattice parameter expected for pseudomorphic alloys as a function of Al content, was estimated from the strain ratios (001) and (111) [1, 2]. It was observed that almost all the layers for both orientations are fully strained. For other hand, the in-plane lattice parameter, was determined from the strain ratios, assuming an elastic deformation and using the EDX alloy composition to interpolate the elastic constants Cij. The behavior of this parameter with Al content, also shows that almost all the layers are fully strained.

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