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ZnO based nanomaterials and nanostructures

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The ZnO-based materials are attractive for the fabrication of optoelectronic devices operating in the blue and ultraviolet spectral regions. The high-pressure rock salt polymorph of ZnO (rs-ZnO) is of particular interest because of the wider opportunities for bandgap engineering as compared to the low-pressure wurtzite phase. However, rs-ZnO could not be quenched down to ambient pressure.

The first objective of the work was the synthesis of various rs ZnO-based phases at high pressure (up to 7.7 GPa) and high temperature (up to 2000 K) and then recovering them at ambient conditions. Three different chemical routes to the rs-ZnO stabilization at ambient conditions have been developed i.e. (i) usage nanosized w-ZnO phase; (ii) usage isostructural MgO or NaCl matrix; (iii) alloying ZnO with the rs-MeIIO (MeII – Mg^{2+}, Ni^{2+}, Fe^{2+}, Co^{2+}, Mn^{2+}) and LiMeIIIO2 (MeIII – Sc^{3+}, Ti^{3+}, Fe^{3+}, In^{3+}) oxides. Thus, a number of materials with advanced electronic and optical properties have been synthesized; and their structural, thermodynamic, luminescent, magnetic and transport properties have been studied. The data obtained shed light on the factors responsible for formation of rs-ZnO under pressure and its recovery down to ambient conditions, which will help to develop the principles of producing new advanced ZnO-based materials.

A few methods were developed for the synthesis of ZnO nanomaterials in the form of nanorods including solvothermal growth, growth from the vapour phase, thermal growth from salt composites, synthesis from alcohol solutions. Only thermal growth from salt composites allows effective doping of ZnO nanorods by transition metals.

Synthesized ZnO nanorods were used for fabrication of nanostructures for measuring luminescent and transport properties. Possible applications of prepared nanostructures are discussed.

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