Phase transformation and enhancement of structural properties on CdSe films with annealing in air atmosphere

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Nanostructured Cadmium Selenide (CdSe) thin films were prepared via evaporation of solvents from a CdSe colloidal solution. Colloidal solution was prepared at room temperature by mixing 4 mmol of cadmium chloride ($CdCl_2$•2.5 H_2O), 2 mmol of selenium elemental powder (Se), 4 mmol of sodium borohydride ($NaBH_4$) and stabilized by adjusting the pH to 8 with 6.5 ml of Extran® ($Na_5P_3O_{10}$, NaOH, and H_2O). The solution was stirred during 30 minutes and cleaned with HCl and H_2O. After that, a glass substrate was introduced in the colloidal solution and heated at 75 °C for 2 h in air environment to evaporate the by-products and a film was obtained on the glass surface. Finally, the as-deposited films were annealing in air atmosphere at different temperatures 50, 100, 200, and 300 °C. The samples were characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS) and High-Resolution Transmission Electron Microscopy (HRTEM).

The XRD pattern of the sample without annealing exhibited zincblende phase and the nanoparticle size was around 5.38 nm. At 100 °C, XRD patterns revealed a combination of zincblende and wurtzite phases. This combination also was observed using selected area electron diffraction (SAED) where the (220) plane of zincblende phase and (100), (002) and (103) planes of wurtzite phase were present in the sample. When the temperature of annealing was increased at 300 °C the wurtzite phase prevailed and crystallite size increased up to 10 nm. The phases and the crystallite size obtained by XRD were confirmed by HRTEM measurements on all samples. In summary, the samples underwent a phase transformation from Zincblende to Wurtzite after an annealing at 300°C. The atomic concentrations measurements made on all films showed an apparent Cd/Se ratio between 1.7 and 2.0, this calculation agree with the composition estimated theoretically.