COLLOIDAL ZnO AND ZnO/MgO CORE/SHELL NANOCRYSTALS - SYNTHESIS AND PROPERTIES

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ZnO nanocrystals nad ZnO/MgO core/shell nanocrystals have interesting biological properties (antibacterial, antifungal). ZnO nanocrystals have recently attracted a lot of attention as promising candidates for novel devices, due to a possibility of continuous tuning of optical and electronic properties by varying the particle sizes. They are also of interest for pharmaceutical industry, medicine and/or biology. Obtained nanocrystals were characterized structurally by Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM) (Fig 1), X-ray diffraction (Fig. 2) and optically by absorption and emission.

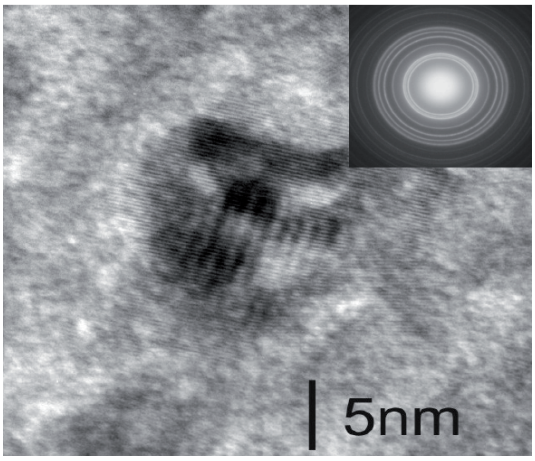

Figure 1. Transmission Electron Microscopy of the ZnO nanocrystals proved a wurtzite crystalline structure.

We prepared ZnO nanocrystals in colloidal suspensions using a sol–gel method. The growth was carried out in various solvents, different incubation times, and temperatures. By measuring the absorbance, and emission of the nanocrystals solution, we monitored the growth. We observed a decrease of the reaction activation energy with an increase in the polarity of the applied solvent. Therefore, the growth rate was higher in a solvent with greater dielectric constant. With increasing nanocrystal sizes the absorption onset was red-shifted. An effective mass approximation model [1] was used to determine the nanocrystal radii. The results were compared with sizes obtained from AFM analysis and a good correlation was found. Depending on conditions and reaction time, we obtained nanocrystals with radii ranging from 2 to 5 nm. Photoluminescence spectra revealed two emission bands. One (narrow 10 nm line width), observed around 375 nm, due to a band-to-band recombination. This PL line behaved analogously to the absorption onset, red-shifted with increasing nanocrystal size. The other emission band was a broad (100 nm line width), centered around 530 nm, probably related to oxygen vacancies.

Addition of MgO shell resulting in a more intense and stable visible emission that is characteristic of nanocrystalline ZnO. MgO prevents aggregation of ZnO nanoparticles.

XRD patterns of powdered ZnO/MgO nanocrystals and TEM data proved wurtzite crystalline structure.

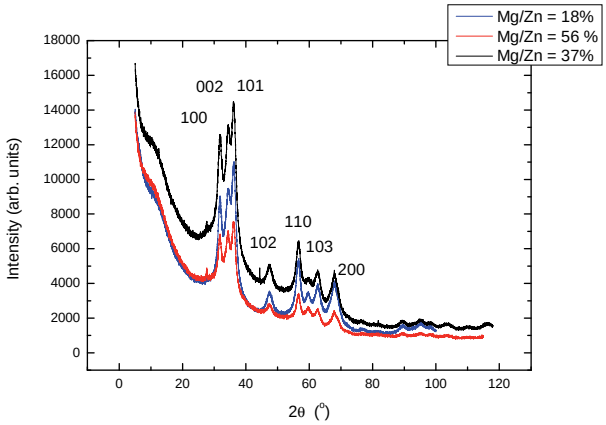

Figure 2. X-ray diffraction pattern (wavelength 1.54060 Å) for ZnO/MgO core/shell powder as a function of thickness shell. The Zn:Mg ratio was: 18%, 37% and 56%. The results proved the wurtzite crystalline structure.

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References

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