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Electron Microscopy Studies of SnO_2 Nanoparticles with Quantum Dots Dimensions Produced Using Ultrasonic Sonochemical Agitation

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SnO_2 is an important n-type wide-energy-gap semiconductor (E_g = 3.64 eV) at 330 ^{0}K Quantum dots (QDs) are semiconducting inorganic nanocrystallites with critical dimensions smaller than or comparable to the exciton Bohr radius of the material, in which carriers or excitons are confined in three dimensions to a nanometers sized region.

Consequently, discrete electronic states, unusual structural transformations, unique optical properties and a blue shift of the band edge transition energy are induced in QDs.

Due to the high surface-to-volume ratio, the surface atoms play a large role in the properties of QDs, which usually have fewer adjacent coordinate atoms and can be treated as defects as compared with the bulk atoms. These defects induce additional electronic states in the band gap, which can be mixed with the intrinsic states to a substantial extent and which may also influence the spacing of the energy levels and the optical properties of QDs, which exhibit unique properties and have a broad range of applications in optoelectronics, telecommunications, lasers and optical sensors

Therefore, simple synthesis routes for SnO_2 nanoparticles with a diameter of less than or comparable to 2.7 nm are extremely important in materials research.

In this work, an electron microscopy study of SnO_2 nanoparticles successfully produced by the Sonochemical procedure is presented. Aqueous solutions of $SnCl_4.5(H_2O)$ with different molarities were under sonochemical agitation at constant solution temperatures around 65 ^{0}C for different times. SnO_2 nanoparticles with size running between 2.5 and 4.5 nm were successfully obtained. After sonication procedure, the samples were dried in an oven at 150 ^{o}C for 2 hours. The samples were studied by Scanning and High Resolution Electron Microscopy. Clusters of SnO_2 nanoparticles with QD dimensions were detected in HREM micrographs. In Figure 1 a HREM micrograph display SnO_2nanoparticles with different orientations; in the upper right side, lattice distances are presented in an histogram. In the upper left side, in a SEM micrograph grains and supported nanoparticles can be appreciated. In Figure 2, dispersed QDs with atomic resolution can be observed. In the inset, a DF STEM micrograph reveals a cluster SnO_2 QDs with sizes around 2.018 nm.

References:

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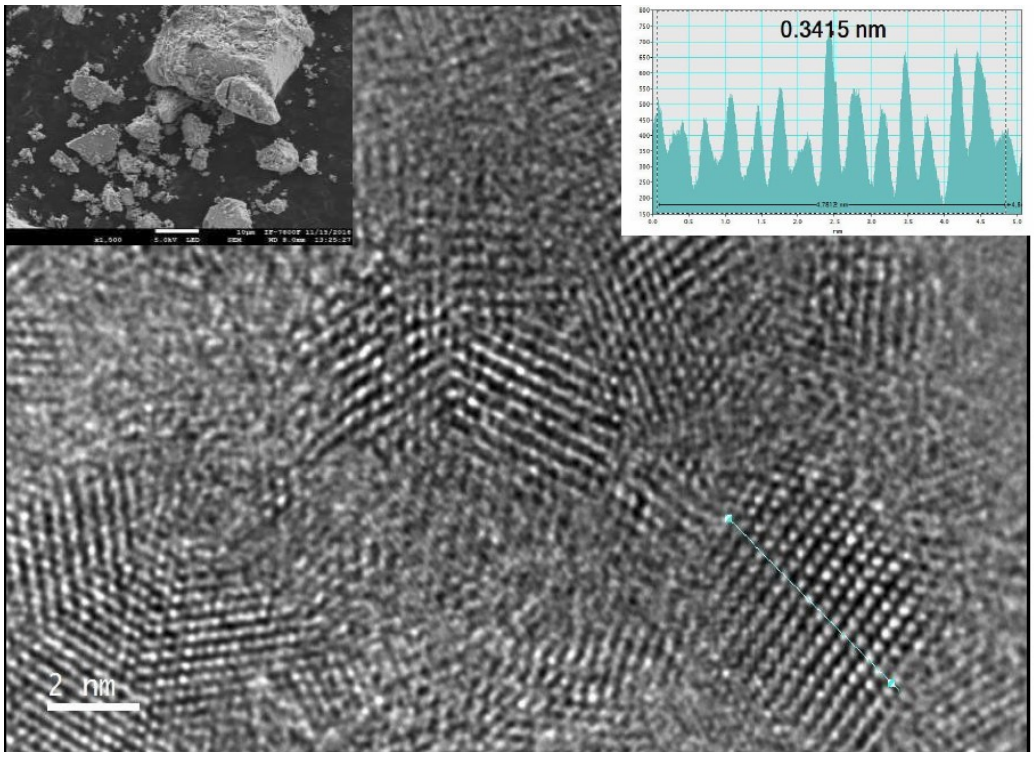

Figure 1. SnO_2 nano particles are displayed in this micrograph.In the upper right side a histogram with lattice distances of 0.3415 nm of zone marked with a light line

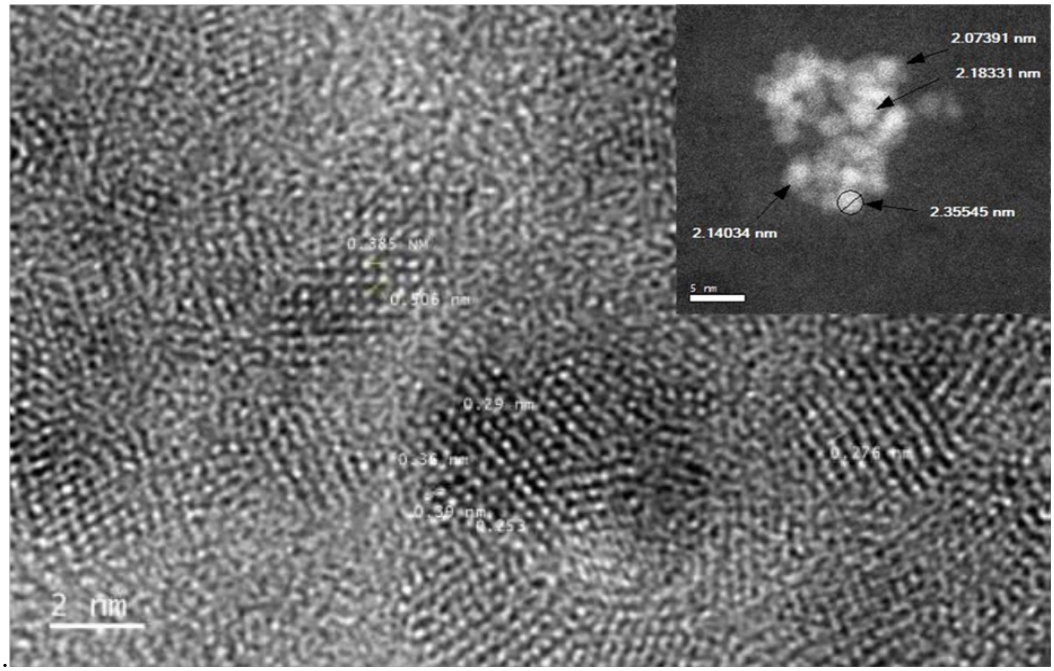

Figure 2. A dispersed cluster of SnO_2 nano particles with QD dimensions is presented in this HREM micrograph. In the inset, a DF STEM micrograph reveals SnO_2 QDs with sizes around 2.018 nm

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