Abstract

Synthesis and characterisation of ZnO nanoparticles. An experimental investigation of some of their size dependent quantum effects
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ZnO nanoparticles in the size range 2.5–7 nm have been synthesised by a wet chemical method where ZnO particles were grown in basic zinc acetate solution. The optical band gap increases when the size of the particles decreases. An empirical relation between the optical band gap given from absorption measurements, and particle size given from XRD measurements has been developed and compared to other similar relations found in the literature.

Time resolved UV-Vis spectroscopy has been used to follow the growth of particles in situ in solution. The data show that the growth mechanism not can be described by a simple Oswald ripening approach and nor by an exclusive agglomeration of smaller clusters into larger particles. The growth mechanism is more likely a combination of the proposed reaction themes. The data also reveal that particle formation do not demand a heating step for formation of the commonly assumed initial cluster Zn₄O(CH₃COO)₆.

Steady state fluorescence has been studied as a function of particle size during growth in solution. These measurements confirm what is found in the literature in that the visible fluorescence is shifted to longer wavelengths and loses in intensity as the particles grow. Some picosecond spectroscopy has also been done where the UV fluorescence has been investigated. From these measurements it is apparent that the lifetime of the fluorescence increases with particle size.

The phonon spectrum of ZnO has been studied with Raman spectroscopy for a number of different particle sizes. From these measurements it is clear that there is a strong quenching of the phonons due to confinement for the small particles, and the only clearly observed vibration is one at 436 cm⁻¹ which intensity strongly increases with particle size.

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