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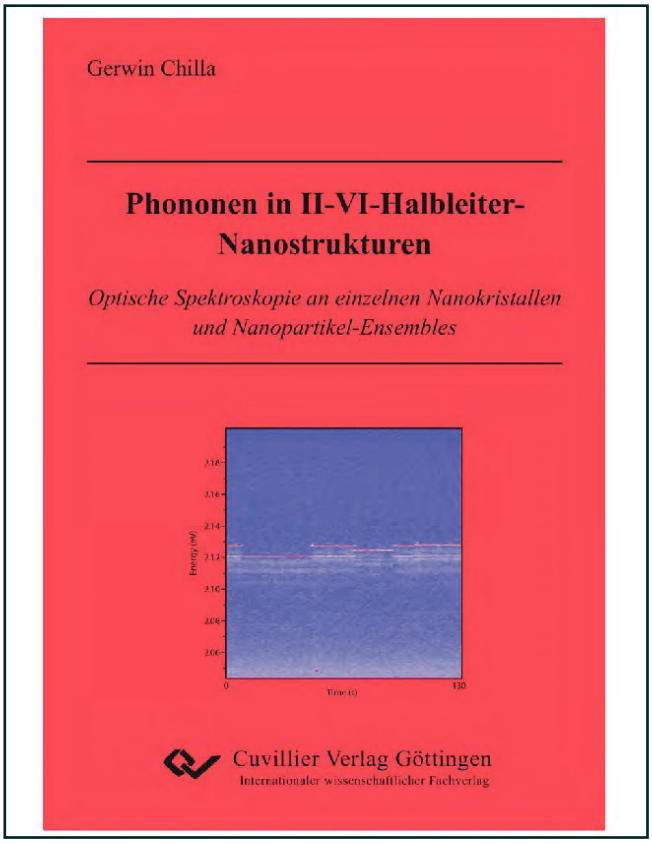
Phononen in II-VI-Halbleiter-Nanostrukturen

Optische Spektroskopie an einzelnen Nanokristallen und Nanopartikel-Ensembles



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Abstract

Phonons in wet-chemical synthesised spherical nanocrystals and tetrapods of II-VI compound semiconductors are investigated.

Using different optical measuring methods, it is firstly aimed at detecting photoluminescence processes in single core/shell and core/shell/shell nanocrystals. Secondly, Raman scattering processes in CdTe nanoparticles are documented.

The main focus of the investigations is optical and acoustical phonons. The phonons are detected in the photoluminescence spectra due to the high stability of the single CdSe nanocrystals. Single phonons are related to confined acoustical modes. Furthermore, nanocrystal-typical effects as blinking and spectral diffusion are discussed by means of consecutively recorded photoluminescence spectra. The Dark-State-Zero-Phonon-Line is the line of highest intensity in the spectra of single nanocrystals. A sideline can be accounted for by recombination from the Bright-State. Based on a model by Lamb [Lam82], three spherical acoustical modes are identified. Both the LA phonon and the LO phonon of the CdSe cores are observed. Moreover, the LO phonons of the CdSe and the ZnS shell are identified.

Polymer films offer a defined environment for CdSe nanocrystals on Si substrate. Spectra from measurements on single nanocrystals of approximately 4.5 hours period (exposure time approximately 2 hours) are presented. Phonon signals of single nanocrystals with a comparatively weak intensity are analyzed by summarized spectra.

Ahead, investigations of InAs quantum dots, embedded in heterostructures, are presented. In these spectra, signatures of single InAs quantum dots are detected.

Likewise, in the Raman spectra of CdTe tetrapods and of the spherical CdTe nanocrystals optical phonons appear. These spectra are taken in ensembles. The findings reveal not only the CdTe phonon and its first harmonic, but also SO phonons. Comparing the results to nanowire-calculations in [Mah03], one excitation is interpreted as TO_x phonon. A further analysis of the CdTe tetrapod and spherical CdTe nanocrystal spectra gives information about electronically transitions in nanoparticles. It is concluded that Raman spectra qualify for differentiating between tetrapods with a well-constructed structure and those with short arms in proportion to the core.

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