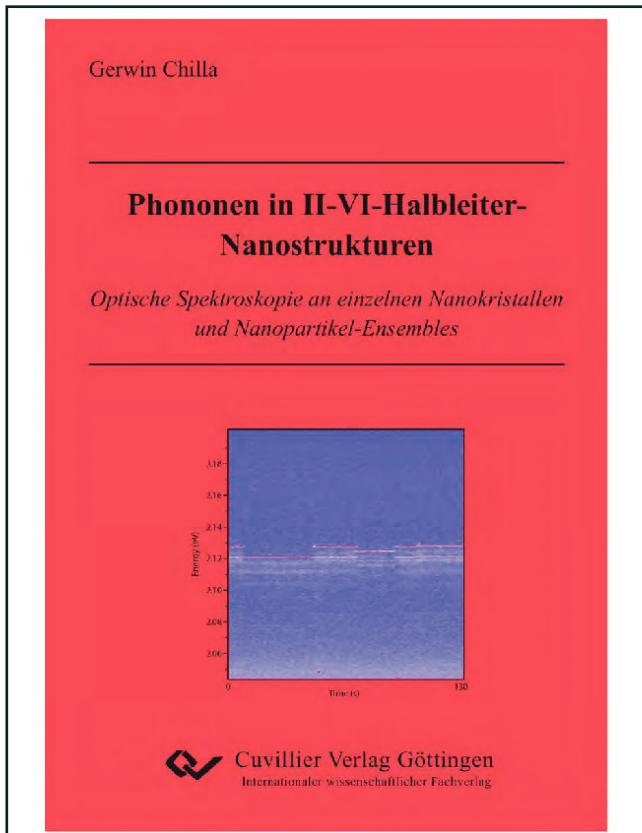




Gerwin Chilla (Autor)

Phononen in II-VI-Halbleiter-Nanostrukturen

Optische Spektroskopie an einzelnen Nanokristallen und Nanopartikel-Ensembles



<https://cuvillier.de/de/shop/publications/959>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

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.

Inhaltsverzeichnis

1	Einleitung	1
2	Optische Spektroskopie an Nanostrukturen	5
2.1	Photolumineszenz-Spektroskopie	5
2.2	Raman-Spektroskopie	7
2.3	Experimenteller Aufbau	9
2.4	Präparation der Proben	11
2.4.1	Proben für Ensemble-Spektroskopie	11
2.4.2	Proben für Spektroskopie an einzelnen CdSe-Nanokristallen	12
2.5	Nasschemische Synthese von Nanopartikeln	14
3	Halbleiter-Nanopartikel	17
3.1	Sphärische CdSe-Nanokristalle	18
3.1.1	Spektrale Diffusion	19
3.1.2	Blinking	21
3.1.3	Ausbleichen	24
3.2	CdTe-Nanopartikel	26
4	Phononen	29
4.1	Optische Phononen in Nanopartikeln	31
4.2	Phononen in sphärischen Nanokristallen	32
5	Photolumineszenz-Spektroskopie an InAs-Quantenpunkten	35
5.1	Herstellung von Halbleiter-Quantenpunkten mittels MBE	35
5.2	Photolumineszenz-Spektroskopie an InAs-Quantenpunkten	37
5.2.1	Vorgehensweise für die Untersuchungen an InAs-Quantenpunkten	37
5.2.2	Ergebnisse der Untersuchungen an InAs-Quantenpunkten	39
6	Ergebnisse	45
6.1	Photolumineszenz-Spektroskopie an einzelnen CdSe-Nanokristallen	45
6.1.1	Einzelne CdSe-Nanokristalle im Überblick	46
6.1.2	Spektrale Diffusion und Blinking	52
6.1.3	Nebenlinien der Zero-Phonon-Line	61
6.2	Raman-Spektroskopie an CdTe-Nanopartikeln	77
6.2.1	CdTe-Tetrapods und sphärische CdTe-Nanokristalle im Überblick	78
6.2.2	Resonanzmessungen an CdTe-Tetrapods	80
6.2.3	CdTe-Tetrapods und sphärische CdTe-Nanokristalle im Vergleich	88

7 Zusammenfassung und Ausblick	97
Literaturverzeichnis	101
Anhang	109
Veröffentlichungen und Tagungsbeiträge	113