INTRINSIC PHOTOLUMINESCENCE STOKES SHIFT IN THIN-FILM CADMIUM SULFIDE

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Introduction. Exciting a semiconductor through light absorption produces photoluminescence (PL). In general, the emitted energy is lower than the energy absorbed. The phenomenon, first discovered in the nineteenth century, is known as Stokes shift energy [1]. The change in energy (A_{Stokes}), crucial for the information about the phonon relaxation in the material and with importance in light emitting devices, has not been investigated experimentally very systematically [2]. In this project, we present the observation of the intrinsic photoluminescence Stokes shift in a semiconductor.

Materials and methods. The cadmium sulfide (CdS) film is formed with ultraviolet pulsed laser deposition (PLD) beam of a Nd:YAG laser (355 nm, 5 ns, 10 Hz) is scanned across a target ofpure (99.999%) sintered CdS powder, while the glass substrate is positioned 3 cm from the target and maintained at 250 °C. The film was characterized through XRD, and then the PL peak energy, Raman peaks, transmission, and reflection spectra in the vicinity of the band gap were measured.

Results and discussion. Analysis of Raman peaks, transmission, reflection, and photoluminescence shows that during band-to-band emission at room temperature one-to-two longitudinal optical phonons with energy of 39.8 meV are emitted. The result is confirmed by the theoretically expected Huang-Rhys factor S (where, AStokes = 2S $h\nu_{LO}$) which is a measure for the numbers of phonons involved in the optical transitions [1].

Conclusions. By the use of high-quality thin-film CdS as the prototyping specimen, the observation of the intrinsic PL Stokes shift in a semiconductor is demonstrated. The experimentally determined Huang-Rhys factor matches the theoretically expected value. For the

latter, a generally valid expression for polar interactions with optical modes is presented, while the experiments demonstrate the required conditions and material quality for the achievement of PL chromaticity in accordance with expectations based on the intrinsic microscopic material parameters, such as dielectric constants, effective masses, and vibronic frequencies.

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