Strongly 2D-confined phonons and their overtones in colloidal nanoplatelets

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The high flexibility of chemical routes for tailoring the properties of colloidal nanocrystals (NCs) and NC-molecule hybrid structures stimulates ever-growing activities on synthesis, investigation, and application [1]. Recently, 2D colloidal semiconductor nanocrystals, or nanoplatelets (NPLs), as thin as 1–2 nm, were obtained [2]. Growing CdSe and CdS subsequently in either side-by-side or stacked manner results in core-crown or core/shell structures, respectively. Both kinds of hetero-NPLs find efficient applications and are interesting materials to study the elemental excitations under strong one-directional confinement.

Here, we report on Raman and infrared spectroscopy study of the phonon spectra and electron-phonon coupling in CdSe/CdS core/shell and core-crown NPLs. The general difference between two NPL morphologies is the larger number of phonon modes in core/shell NPLs, their spectral shifts with change of shell thickness or Eexc, as well as resulting overtone spectra, which are further modified by tuning the laser excitation energy Eexc between in- and off-resonant conditions. The spectra of the core-crown NPLs resemble more the sum of spectra of the isolated CdSe and CdS particles and are similar to spherical morphologies studied earlier. This behaviour is explained by mutual influence of the core and shell in NPLs and formation of combined modes. In the core-crown structure, the CdSe and CdS modes preserve a more independent behaviour with only interface modes forming overtones with core phonons.

Fig. 1. Representative resonant Raman spectra of two types of CdSe/CdS NPL morphologies shown in the insets.

Keywords: Semiconductor Nanocrystals; Nanoplatelets; Interface; Core-Shell; Phonons; Raman; Infrared Spectroscopy.

References