SURFACE-ENHANCED RAMAN SCATTERING BY SEMICONDUCTOR NANOSTRUCTURES

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The surface enhanced Raman scattering (SERS) is one of the most powerful optical methods for studying vibrational states in chemical and biological substances enhanced in the vicinity of metal nanoclusters. Much less is known about SERS by phonons from inorganic nanostructured materials such as nanocrystals (NCs), nanorods etc.

We present a study of SERS by confined and surface optical phonons in dense arrays of CdS, ZnO, and CuS NCs [1-3] as well as GaN and ZnO nanorods [3] fabricated by various methods and decorated with Ag nanocusters that allowed detailed analysis of phonon spectrum in the nanostructures. The focus of our interest is the vibrational spectrum in a single NC or nanorod because it is composed of a rich set of phonon modes predicted theoretically. However, the relatively small Raman cross-section complicates the observation of phonons in single nanoobject.

Therefore, the key point is the elaboration of appropriate approaches for increasing the Raman efficiency of NCs with a low areal density by means resonant SERS which takes place by coincidence of the energies of laser light, surface plasmons in metal nanoclusters, and interband transitions in NCs or by using the interference-enhanced Raman scattering accomplishing SERS effect.

We present our last results of SERS study of CuS and ZnO NCs with a low areal density fabricated using the Langmuir-Blodgett technique. NCs were deposited on laterally ordered arrays of Au nanoclusters formed by the electron beam lithography on Si substrates. Morphology of semiconductor NCs and metal nanocluster arrays was controlled by scanning electron microscopy. The Raman experiments were performed by using a Horiba LabRam spectrometer equipped with a micro-Raman setup with laser excitation wavelengths of Ar\textsuperscript{+} and K\textsuperscript{+} lasers.

SERS by optical phonons in ZnO and CuS NCs put in the vicinity of laterally ordered Au nanoclusters was demonstrated. SERS effect by optical phonons in CuS NC made possible the observation of phonon modes in CuS and ZnO NCs with ultra-low areal density. The further ways of Raman scattering enhancement by phonons in semiconductor NCs are discussed.

Keywords: Surface-Enhanced Raman spectroscopy; phonons; nanocrystals; quantum dots

References