In-plane Raman scattering by acoustic phonons in InAs/AlAs and Ge/Si quantum dot superlattices

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We present the results of micro-Raman scattering study of acoustic phonons of InAs/AlAs and Ge/Si quantum dot superlattices grown by molecular beam epitaxy in the Stranski-Krastanow growth mode on (001)-oriented GaAs and Si substrates, respectively. InAs/AlAs structures are composed of 20 periods of InAs QD layers with a nominal thickness of 2.8 monolayers separated by 6, 8, 10, and 13 nm of AlAs. The Ge/Si nanostructure consists of 10 Ge and Si layers with nominal thicknesses of 1.4 and 30 nm, respectively.

The micro-Raman scattering experiments were performed using a micro-Raman setup with the 514.5 nm line of an Ar^+ laser. The laser light with a spot size of 1 μm was focused either on a planar sample surface or a cleaved (110)-oriented sample edge.

Raman scattering from the planar surface and the cleaved (110)-oriented edge of the nanostructures was investigated. All possible doublets of folded longitudinal acoustic (FLA) phonons and a number of doublets of FLA phonons (up to 12th order) were observed in the Raman spectra of InAs/AlAs and Ge/Si nanostructures, respectively, measured in the z(x,x)-z scattering geometry (Fig.1). The energy positions of the FLA doublets are well described by the elastic continuum model of Rytov. The in-plane Raman scattering spectra measured in the y'(x',x')-y' geometry reveal the changing energy positions and intensities of the FLA doublet components which are consistent with changing the effective wave vector in the nanostructures induced by the momentum transfer of the light. The Raman selection rules for the FLA phonons with different symmetries in the both type of nanostructures are discussed.

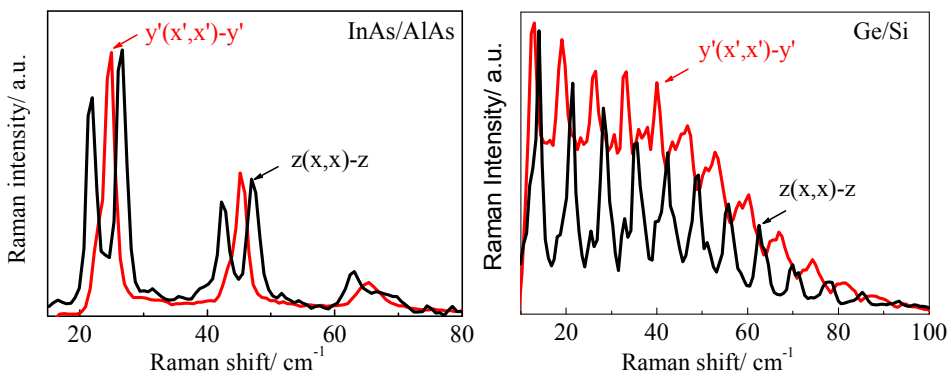

Fig.1 Raman spectra of InAs/AlAs and Ge/Si quantum dot superlattices measured in backscattering from the (100) and (110) planes (black and red curves, respectively).