Size-selective Raman scattering in self-assembled Ge/Si quantum dot superlattices

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Abstract. Self-organized Ge quantum dot (QD) superlattices having properties of two- and zero-dimensional structures were investigated by Raman spectroscopy. Longitudinal optical (LO) Ge phonons, longitudinal (L) Ge-Si phonons and folded longitudinal acoustic (LA) phonons superimposed on a strong continuous emission were studied under resonant conditions. The measured phonon frequencies of folded LA phonons up to 15th order are in good agreement with those calculated using the Rytov model applied usually to planar superlattices. The low-frequency continuous emission can be explained in terms of a breakdown of crystal momentum conservation for resonant Raman processes involving acoustic phonons. A frequency enlargement of the continuous emission band and a downward shift of the LO Ge phonons with increasing excitation energy (2.54-2.71 eV) are attributed to electron and phonon size confinement in the small Ge QDs resonantly contributing to the scattering process. The size of the QDs involved in the process is estimated from analysis of the frequency position of their optical phonons.

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