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Influence of oxidation conditions on the formation of InAs quantum dots in an aluminum oxide matrix

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Publication: *Proc. SPIE Vol. 5227*, p. 282-287, Advanced Topics in Optoelectronics, Microelectronics, and Nanotechnologies; Ovidiu Iancu, Adrian Manea, Dan Cojoc; Eds.

Publication Date: Oct 2003

Abstract

Raman spectroscopy which provides valuable information on the structural parameters of QDs was used for monitoring of the lateral oxidation of InAs/AlAs QD structures and study of the phonon properties of InAs QDs in aluminium oxide matrix. Optical phonons of InAs QDs were found to be affected by both strain and confinement. Raman spectra measured from non-oxidized area reveal asymmetric lineshape of LO phonons in InAs QDs and demonstrate its low-frequency shift with increasing excitation energy that is explained by QD size distribution and phonon confinement in smaller-size dots. Raman spectra taken from oxidized area show an increase of the LO peak intensity and the shift of the phonon line position towards higher frequency. The first effect is explained by formation of wide bandgap aluminium oxide matrix that leads to the shift of confined electronic states in InAs QDs closer to the resonance with the laser excitation energy. The latter is caused by increasing mechanical strain in InAs QDs due to a shrinkage of the aluminium oxide layers. At the boundaries of oxidized/non-oxidized areas the presence of amorphous and crystalline As clusters is evident.

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