RAMAN SPECTROSCOPY CHARACTERIZATION OF InAs SELF-ASSEMBLED QUANTUM DOTS

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The zero dimensional semiconductor quantum dots, where the carriers are confined in all three spatial dimensions are promising candidates for the implementation of electronic and opto-electronic devices. These structures are easily obtained by the transformation of a strained layer into an assembly of islands of atoms, when the two-dimensional growth changes into a three-dimensional one; this is the Stranski-Krastanow method, and the dots so formed are the so-called self-assembled quantum dots (SAQDs).

Among the techniques used in order to characterize the structures of these low dimensional structures, the Raman scattering study of the phonons can be considered as one of the most powerful. We here report intensive Raman spectroscopy studies of the InAs SAQDs grown on GaAs in different conditions, that confirm the potentiality of this tool.

First, undoped multi-layered samples were analyzed under resonant conditions (with the $E_0 + \Delta_0$ electron excitations confined in the dots) and the study of the observed interface modes localized near the edges of the dots, gave informations about the topology of the dots and that a similar topology occurs on both sides of the layer were they are formed [1]. Moreover, the spectra were shown to be sensitive to the vertical separation between the dots.

In the second case, doped samples were studied and the coupled LO-plasmon phonon modes were observed [2]. The frequency shifts of these modes with respect to the bare LO-phonon frequency gave an evidence of the presence of free electrons. The absence of the coupled modes in the structures with more than one layer, testified that in these samples the electrons are localized inside the InAs dots, thus not contributing to the plasmon vibrations.

Finally, post-growth annealing effects were analyzed both in single and in multi-layered doped SAQDs. From the observed behavior of the InAs TO mode and the GaAs one phonon density of states, at different annealing temperatures, it was possible to conclude that the heat treatments at temperatures somewhat higher than the growth temperature (450 ^{0}C), result in a drastic modification of the multi-layered SAQDs (and the formation of an InGaAs alloy already at 600 ^{0}C); the single layer structure, however, revealed thermal stability even at rather high temperatures, what confirms the role of the interlayer strain in the low temperature diffusion process.

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2) A. J. Chiquito, Y. A. Pusep, S. Mergulhão, J. C. Galzerani, N. T. Moshegov and D. L. Miller, J. Appl. Phys. **88**, 1987 (2000).