# Synchrotron x-ray scattering studies of self-assembled semiconductors islands

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In this talk we review a number of x-ray experiments where the structural properties of self-assembled semiconductor nanostructures were studied. We have used a combination of synchrotron x-ray scattering, atomic force microscopy and electron microscopy to determine the strain state of different island systems grown under Stranski-Krastanov mode.

A) Grazing incidence x-ray scattering was employed as a method to identify relaxed islands in an ensemble of partially coherent self-assembled InAs quantum dots. A simple model of strained pyramidal islands enabled the association of the local lattice parameter of an island to its lateral size. A comparison between the island side length and its strain state allowed the identification of coherent and incoherent nanostructures, revealing the size-strain interplay during growth [1].

B) We have directly measured the gradient of composition and strain in Ge nanocrystals (pyramids and domes) grown on Si(001) using anomalous x-ray scattering. By combining our x-ray results, where we relate strain, interdiffusion and shape, with atomic force microscopy measurements, we have been able to determine the complete strain configuration of these islands. We show that the transition from pyramids to domes is accompanied by an increase of lattice parameter and enhancement of interdiffusion, both leading to a drastic decrease of the elastic energy stored per atom [2].

C) By comparing the strain state in different crystallographic direction we have observed a remarkable strain anisotropy in InAs/GaAs self assembled wires. We show that there is a sizeable stress effect of the wire on the substrate, which can be almost as strained as the nanostructure itself. This result was independently confirmed by transmission electron microscopy. Future experiments will also be discussed, especially the potential of synchrotron radiation in revealing the strain and composition of quaternary island systems, such as InP/GaAs (001).

All experiments were performed at the Laboratório Nacional de Luz Síncrotron (LNLS), in Campinas, SP.

[1] A. Malachias, R. Magalhães-Paniago, B. R. A. Neves, W. N. Rodrigues, M. V. B. Moreira, H.-D. Pfannes, A. G. de Oliveira, S. Kycia and T. H. Metzger, Appl. Phys. Lett. 79, 4342 (2001).

[2] R. Magalhães-Paniago, G.Medeiros-Ribeiro, A. Malachias, S. Kycia, T.I. Kamins and R. Stan Williams, Phys. Rev. B (in press).

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