SUBSTRATE ORIENTATION EFFECTS ON THE LATTICE PARAMETER PROFILES IN THE STRANSKI-KRASTANOV GROWTH MODE

S.N. Santalla[1], C. Kanyinda-Malu[1,2] and R.M. de la Cruz[1]

(1) Departamento de Física, Universidad Carlos III de Madrid, EPS, Av. de la Universidad 30, 28911 Leganés (Madrid), Spain.

(2) Departamento de Economía Financiera y Contabilidad II, FCJS, Universidad Rey Juan Carlos, Paseo de los Artilleros s/n, 28032 Madrid, Spain.
E-mail: silvia.santalla@uc3m.es

One of the factors which greatly influences the Stranski-Krastanov (S-K) growth mode in low-dimensional strained heterostructures is the substrate orientation. A change in the Miller indices of the substrate allows to control the strain relaxation in the heteroepitaxial systems and consequently induces modifications in the onset of the S-K growth mode. For instance, when InAs epitaxial layers were grown on high index substrates such as (113) and (115) GaAs, the PL spectra indicated a delay in the three-dimensional mode onset [1]. Besides, appropriate changes of substrate orientation induce different morphologies of the islands for the same epitaxial film. This phenomenon is observed by STM in Ge/Si (001) and Ge/Si (111) quantum dots (QDs) [2]. Theoretical studies to investigate the substrate orientation effects on S-K growth mode and electronic properties of Ge/Si (111) and InAs/GaAs (11n) QDs were also reported [3, 4].
In our previous work, we reported analysis of the parameter profile using elasticity continuum theory in Ge/Si (001) and InAs/GaAs (001) QDs for different values of the aspect ratio [5]. Following that theoretical treatment, we will investigate the substrate orientation effects on the lattice parameter profiles in Ge/Si (111) and InAs/GaAs (11n) QDs. As in the previous works, we assume that a small fraction of the substrate ($0 < \alpha < 1$) participates in heterostructure relaxation in the non rigid approximation. Minimization of the free energy by the Euler-Lagrange method allows to analyse the evolution of the lattice parameter with the film coverage. In both rigid and non-rigid approximations, a sigmoidal-like profile is obtained for the lattice parameter. The figure 1 shows the lattice parameter profile for Ge/Si (111) QDs with aspect ratio of $r = 0.6$ and we compare it with Ge/Si(001) in non-rigid approximation. Comparison with the profiles obtained with the smaller Miller indices in InAs/GaAs QDs [5] will also discussed.

References:

[1] Sanguinetti, S.; Chiantoni, G.; Grilli, E.; Guzzi, M. ; Henini, M. ; Polimeni, A. ; Patané, A. ; Eaves, L. and Main, P.C., *Mater. Sci. Eng. B* **74** (2000) 239.
[2] Voigtländer, B., *Surf. Sci. Rep.* **43** (2001) 127.
[3] Santalla, S. N. ; Kanyinda-Malu, C. and de la Cruz, R. M., *Nanotecnology* **15** (2004) S215.
[4] Santalla, S. N.; Kanyinda-Malu, C. and de la Cruz, R.M., *Physica E* **25** (2005) 456.
[5] Santalla, S. N.; Kanyinda-Malu, C. and de la Cruz, R. M., *Nanotechnology* **18** (2007) 315705-1.

Figures:

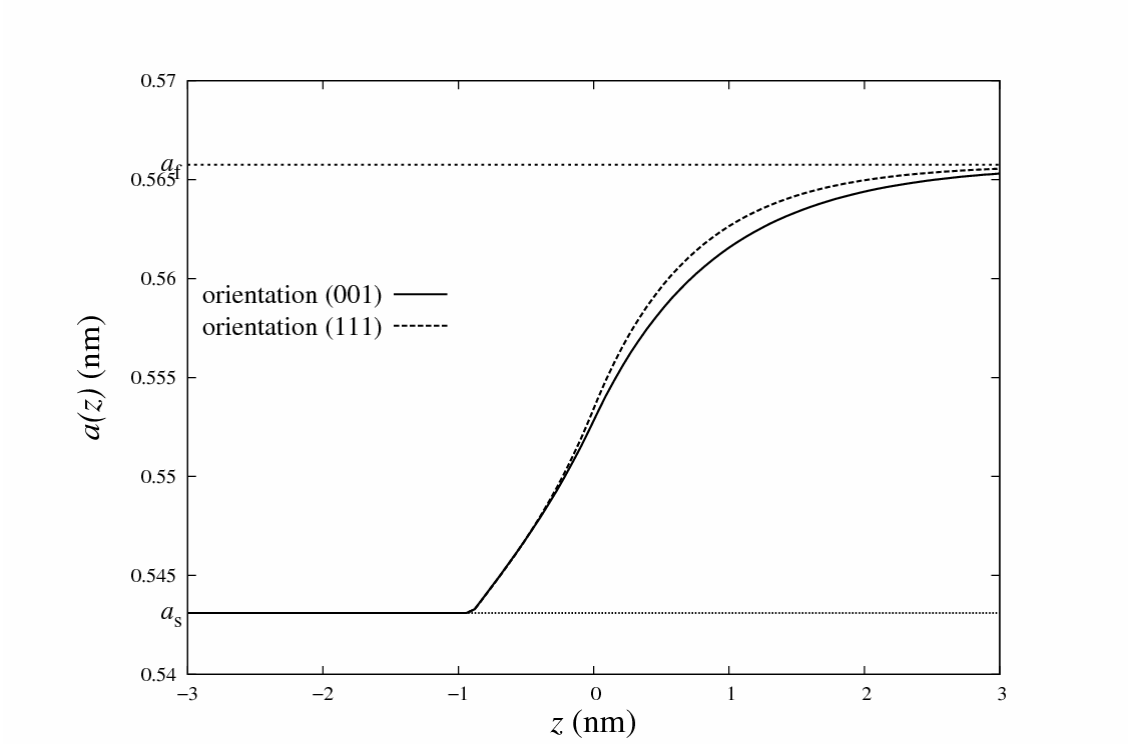

Figure 1: Lattice parameter profiles as a function of film coverage in Ge/Si (001) and Ge/Si (111) QDs for $\alpha = 0.3$ and $r = 0.6$.