Dependence of the Ge nanostructure formation on B delta doping during MBE growth

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Resumen

The morphology of Ge islands or quantum dots epitaxially deposited on Si is largely determined by the balance of strain at the growth interface. Self-assembled dots are formed mainly due to elastic strain relaxation mechanisms such as surface coarsening and Si-Ge intermixing. Standard growth of Ge on Si (001) is a clear example of a Stranski-Krastanow (SK) process, where the typical island shapes can be basically classified into two main types: pyramids and domes, whose relative abundance depends on the growth temperature and the total Ge coverage.

Addition of impurity atoms to the growing interface can alter the strain balance and as a result change the resulting distribution of island shapes. A very effective impurity in this system is C, and has been widely studied. For certain technological applications it is of interest to grow doped heterostructures with Ge/Si quantum dots. The typical p-type dopant in Si technology is B which can also be used to modify the growth modes of dots.

Here we present an Scanning Force Microscopy (SFM) study of the influence of B delta doping on the surface structure of Ge nanostructures formed during growth. The samples were prepared by solid-source molecular beam epitaxy (MBE). The growth sequence on a substrate with a 100 nm undoped Si layer was nominally the following: 20 nm of B doped Si, 3 monolayers (MLs) of Ge, a fraction x ML of B (delta doping-like), and finally 5 MLs of Ge. We present results for different samples for x ranging from 0 to 0.2 submonolayer B deposition which evidence its influence on the 3D island formation. Analysis of the basal surface layer morphology and roughness as well as the island density, aspect-ratio and island faceting is presented. Because of the compatibility with planar device technology, the successful control of the Ge island size and density on Si, in this case by means of B doping, results enormously attractive for future nanoelectronic and photonic devices.

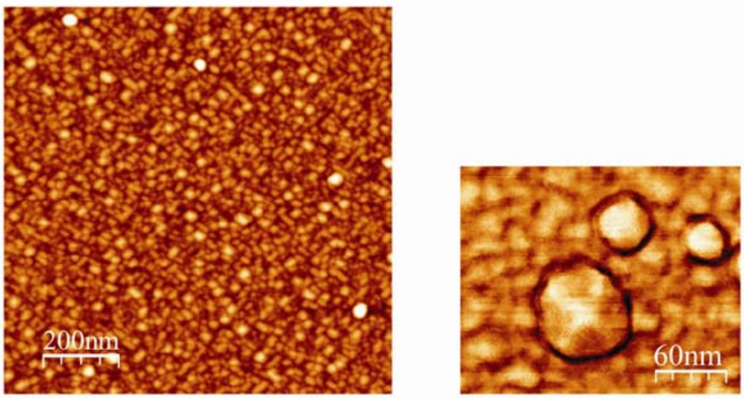

Figure 1. SFM images showing the surface structure and faceted Ge nanostructures