NANODOT PATTERNING OF SILICON SURFACES BY ION BEAM SPUTTERING

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The actual tendency of many technological processes requires the implementation of functional structures in the nanoscale range. In order to achieve defined structures with such dimensions, the use of self-organisation processes is gaining much attention recently. Among the "bottom-up" self-organized process, ion beam sputtering (IBS) has been shown to be a promising alternative [1]. In particular, ripple morphologies and regular arrays of dots can be produced on the irradiated surface, as those shown in Figure 1. Ripple morphologies are attained for off-normal ion irradiation whereas nanodots result under normal or isotropic ion incidence. The nanodot formation has been reported on several semiconductor systems such as GaSb, InP, Si, InAs and InSb [2]. While the formation of ripple patterns has been investigated experimentally and theoretically for a long time, the formation of regular dot arrays has gained attention only recently and is not yet fully understood [3].

Here, nanodot patterns were produced on Si(001) and Si(111) surfaces by low-energy (0.5-1 keV) Ar^+ ion bombardment at normal incidence. The resulting surface morphology was studied by means of atomic force microscopy (AFM), transmission electron microscopy (TEM), Rutherford Backscattering Spectrometry (RBS) in the channelling mode and surface-sensitive x-ray techniques at the European Synchrotron Radiation Facility (ESRF). These measurements provide complementary information about morphology, ordering and strain of the evolving nanostructures. The temporal evolution of the morphological features during the sputtering process, as well as the influence of the sputtering parameters on the pattern characteristics is addressed. Special attention is devoted to the crystallinity of the nanostructures and the role of the surface amorphous layer on the pattern formation. The results obtained not only have technological implications regarding the control over the pattern characteristics but also provide relevant information to contrast the existing theories of pattern formation by IBS. In particular, the introduction of a continuum 'hydrodynamic' model exploiting the analogy with aeolian sand dunes formation is highlighted [4].

References:

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Figures:

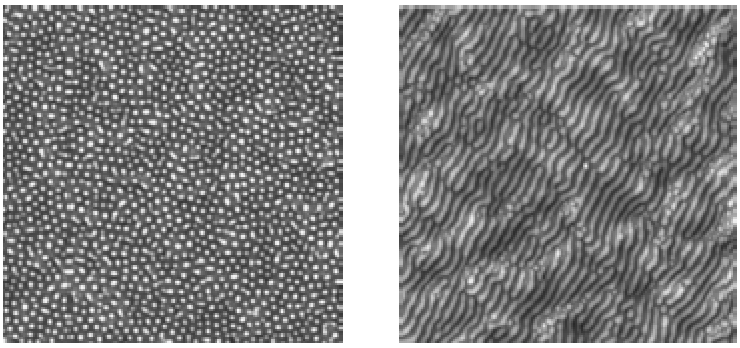

Figure 1: AFM images (2x2 μm^2) of Si(100) nanostructured surfaces after 5 min of Ar^+ ion sputtering under normal (left, nanodots) and off-normal (right, nano-ripples) ion incidence.