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Self-ordering on vicinal surfaces studied by 3D GISAXS measurements

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Nanostructured systems made of islands deposited onto oxide surfaces have both fundamental and technological interests and are used in the field of electronic, linear or non-linear optic, and optoelectronic. The final properties of these systems depend on the shape and the size of nanoparticles and also on their organization. On this general framework, we aim at producing self-organized nanostructures using vicinal surfaces [1],[2]. Vicinal surfaces are obtained by cutting a single crystal with a small deviation of the surface normal with respect to a crystallographic plane leading to a surface with terraces separated by steps. Suitable templates for the growth of self-organized nanostructures are created thanks to the re-arrangement of the steps during thermal treatment (step bunching). Different types of nanostructured surfaces can be elaborated and used as templates since the substrates exhibit a one-dimensional (1D) or two-dimensional (2D) periodic patterns (fig. 1a). The surface morphology and the periodicity can be tuned with the thermal treatment parameters (i.e. annealing time, temperature and atmosphere) and also with the sample parameters (i.e. miscut and azimuthal angles). Ordered stepped oxide surfaces are characterized ex-situ after each treatment on a laboratory scale by Atomic Force Microscopy (AFM), which provide a direct image of the surface morphology (step height, step curvature, terrace width...) over a small probed area (a few µm²). Quantitative analysis of the surface morphology has been studied by grazing incidence small angle scattering using a specific set-up implemented recently onto the BM02 beamline at ESRF (Grenoble, France). Prior to the SAXS measurements, the samples were strictly oriented according to the primary beam direction using a 3-axis sample holder. 3D reciprocal space maps around the (000) node were then recorded onto a 2D pixel detector through 360° rotation of the samples around the azimuthal angle. Modelling of 2D sections of the (000) reciprocal space node were realized using the FitGISAXS software [3]. Typical experimental and calculated maps are reported fig. 1b and 1c. We demonstrate that the 2D ordered surface is consistent with a rectangular centred periodic lattice decorated by truncated tetrahedrons (see fig. 1d).

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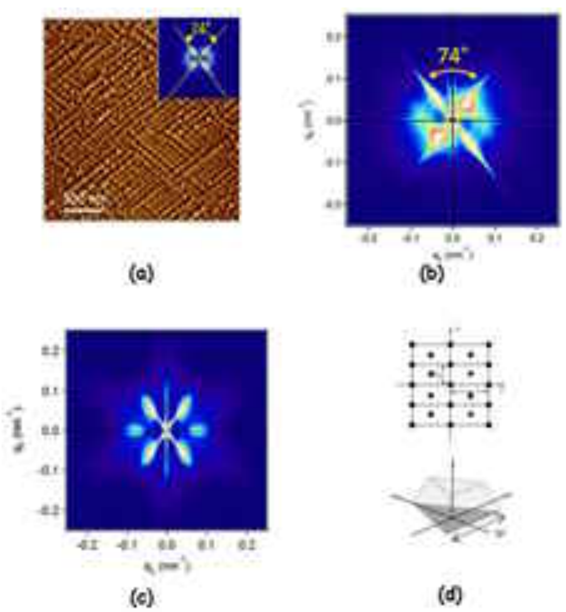

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