SELF-ASSEMBLING AND GUIDED SELF-ORGANIZATION OF OXIDE NANOSTRUCTURES FROM CHEMICAL SOLUTIONS

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The appearance of new functionalities and devices arising from size- and shape-dependent properties has triggered the interest in creating well-defined structures at the nanometric-scale. Self-organizing and self-assembling processes following a bottom-up approach can easily decrease the size limit and also cover cost-effectively much larger surfaces. We present a general methodology for the generation of strain-induced self-assembled oxide nanostructures grown from chemical solutions, a bottom up technique with great potentiality Control and tuning of morphology, size, distribution and orientation of the resulting interfacial oxide nanostructures through processing parameters like time, atmosphere, temperature is achieved. In particular, special attention is given to the growth of fluorite $Ce_{1-x}Gd_xO_{2-y}$ (CGO) on perovskite single crystalline substrates in which case the particular orientations of the oxide nanostructures, (011)CGO[1-10]||(001)ABO_3[100], (001)CGO[110]||(001)ABO_3[100], (011)CGO[1-10]||(011)ABO_3[110] controls the different kinetics and make it very suitable for the study of mechanisms leading the evolution of the interfacial nanostructures [1]. The interplay between interfacial energy and strain relaxation energy determine the resulting shape instability giving rise to elongated nanowalls with lateral aspect ratio (c=long axis/small axis) as large as c~35 (see Figure 1). However, self-organization and localization control of these nanostructures is a complex issue unless they are guided by assisted methodologies. Mechanical modification of the substrate by means of Nanoindentation has been used for assisting the self-organization of $Ce_{0.9}Gd_{0.1}O_{2-y}$ nanoislands. We will demonstrate that the application of ultra low loads, <10 nN, and deformations <100 nm, on the single crystal perovskite substrate results in the localization and orientation of the $Ce_{1-x}Gd_xO_{2-y}$ nanowalls along the nanoindented scratches (see Figure 2). The controlled alteration of the relaxation and interfacial energies by the appearance of convex and concave curvatures, are at the origin of the observed CGO localization.

[1] M. Gibert et al., Advanced Materials, **19**, 3937 – 3942 (2007)

We acknowledge financial support from MEC (MAT2005-02047, NAN2004-09133-C03-01, MAT2006-26543-E;FPU, Consolider NANOSELCT), Generalitat de Catalunya (Pla de Recerca SGR-0029 and CeRMAE), CSIC(PIF-CANNAMUS) and EU (HIPERCHEM, NESPA)

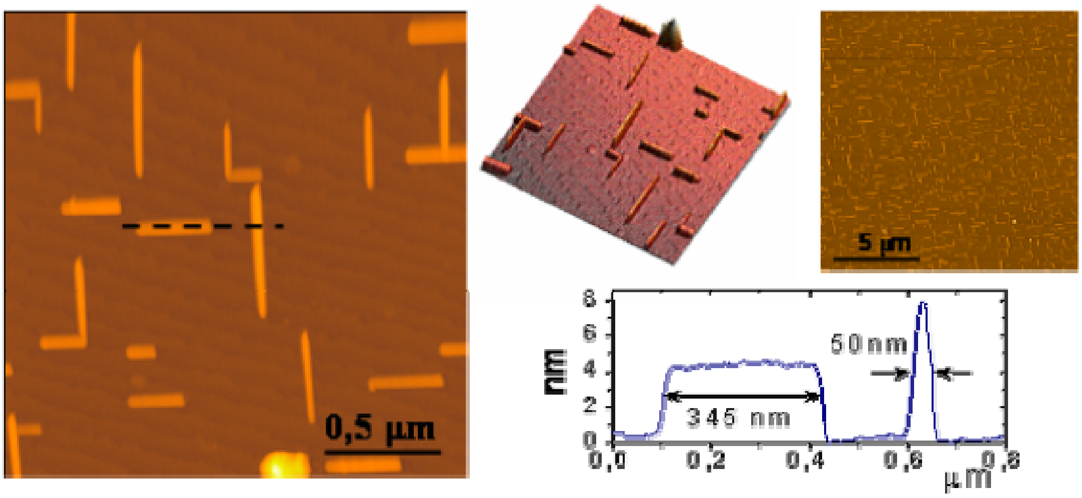

Figure 1. Highly anisotropic self-assembled $Ce_{1-x}Gd_xO_{2-y}$ nanostructures on $LaAlO_3$ prepared from chemical solutions

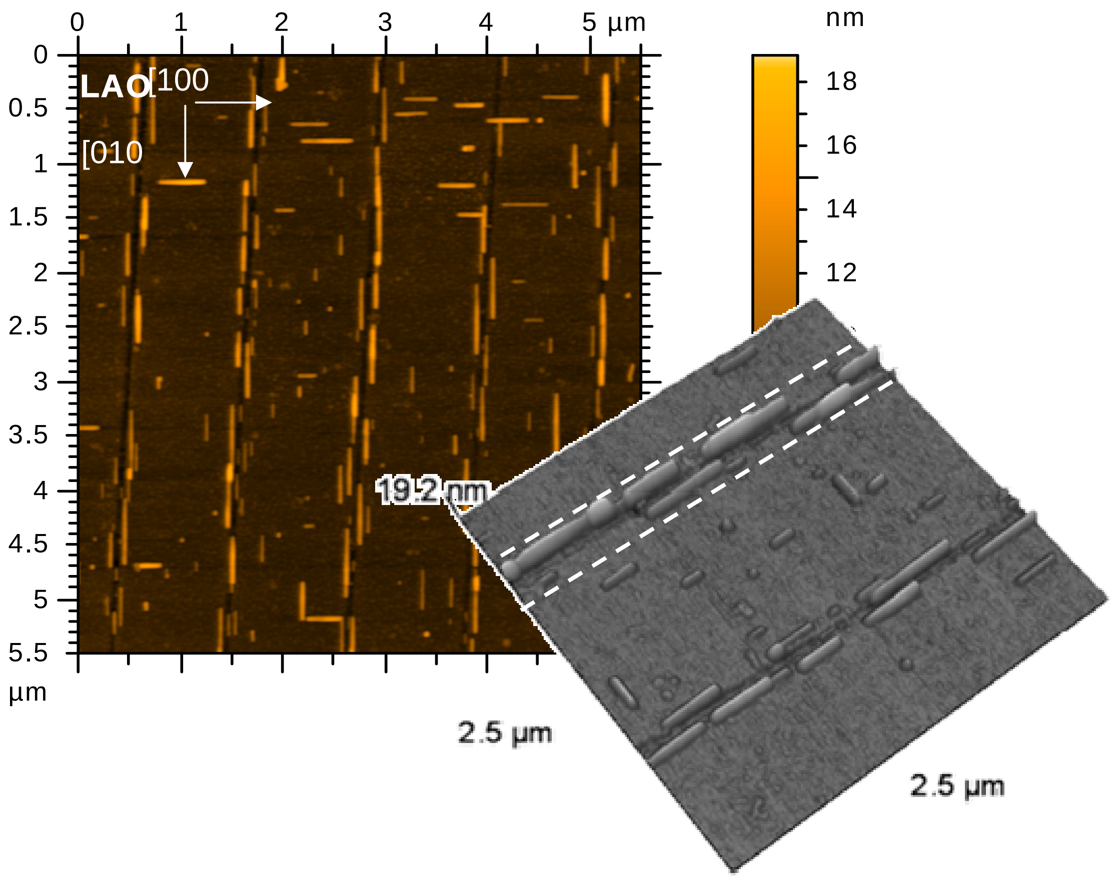

Figure 2. $Ce_{0.9}Gd_{0.1}O_2$ nanowalls grown on $LaAlO_3$ single crystals where controlled scratched deformation by nanoindentation has been previously performed. The localization and orientation of the nanowalls is determined by the nanoindented regions.