Type of presentation: Poster

MS-5-P-3060 Characterization by aberration corrected STEM-EELS of YSZ epitaxial thin films

Cabero M.[1], Rivera Calzada A.[1], Pennycook T. J.[2,3], Varela M.[4,1], Pennycook S. J.[5], Leon C.[1], Santamaría J.[1]

[1]GFMC, Universidad Complutense de Madrid. Madrid 28040, Spain, [2]Department of Materials, University of Oxford, Parks Road, Oxford, OX1 3PH, UK, [3]SuperSTEM Laboratory, Daresbury, WA4 4AD, UK, [4]Oak Ridge National Laboratory, Oak Ridge TN 37831, [5]The University of Tennessee, Department of Materials Science and Engineering, Knoxville TN 37996-2200, USA

Email of the presenting author: marionacabero@ucm.es

The search of novel materials with enhanced ionic conductivity for their application in energy devices is an exciting direction in the expanding field of oxide interfaces [1]. In particular, exploiting size effects in ionic conducting materials by the controlled reduction of sample dimensions down to the nanoscale holds the promise to yield large improvements in the performance of oxide based devices for energy generation and storage [1-3]. Epitaxial strain is a key parameter to tune the enhancement of ion mobility at interfaces. A good example can be found in the colossal increase of ionic conductivity observed in $SrTiO_3/Y_2O_3:ZrO_2$ (STO/YSZ) superlattices, which has been the subject of intense debate [4-9]. It has been suggested that disorder in the O sublattice at the interface, transfer of vacancies or interface reconstructions may be responsible for the enhancement in ionic conductivity. Aberration-corrected scanning transmission electron microscopy combined with electron energy loss spectroscopy (STEM-EELS) is a powerful technique capable of providing simultaneous information about structure, chemistry and electronic properties of materials. In this work we apply these techniques to the study of STO/YSZ interfaces and we will discuss the structure, chemistry and physical properties of fluorite/perovskite interfaces (as shown in Figure 1) of (111) oriented $ZrO_2:Y_2O_3$ (YSZ) films epitaxially grown on top of (1-10) $YAlO_3$(YAP) substrates (with small epitaxial mismatch), where an enhancement of 5 orders of magnitude in ionic conductivity has been measured near room temperature. Research at ORNL supported by U.S. Department of Energy (DOE), Basic Energy Sciences (BES), Materials Sciences and Engineering Division. Research at UCM supported by the ERC starting Investigator Award, grant #239739 STEMOX. SuperSTEM is the EPSRC UK National Facility for Aberration-Corrected STEM.

[1] B. C. H. Steele and A. Heinzel, *Nature* (2001) **414**, 345.

[2] N. Sata, K. Eberman, K. Eberl and J. Maier, *Nature* (2000), **408**, 946.

[3] J. Maier, *Nature Materials* (2005) **4**, 805-815.

[4] J. García-Barriocanal et al., *Science* (2008) **321**, 676-680.

[5] X. Guo et al., *Science* (2009) **324**, 465a.

[6] A. Cavallaro et al., *Solid State Ionics* (2010) **181**, 592-601.

[7] T. J. Pennycook et al., *Physical Review Letters* (2010) **104**, 115901.

[8] A. Rivera-Calzada et al., *Advanced Materials* (2011) **23**, 5268.

[9] T. J. Pennycook et at., *The European Physical Journal Applied Physics* (2011) **54**, 33507.

Acknowledgement: We also acknowledge support from Spanish MICINN through grants MAT2011-27470-C02 and Consolider Ingenio 2010-CSD2009-00013 (Imagine), from CAM through grant S2009/MAT-1756 (Phama).

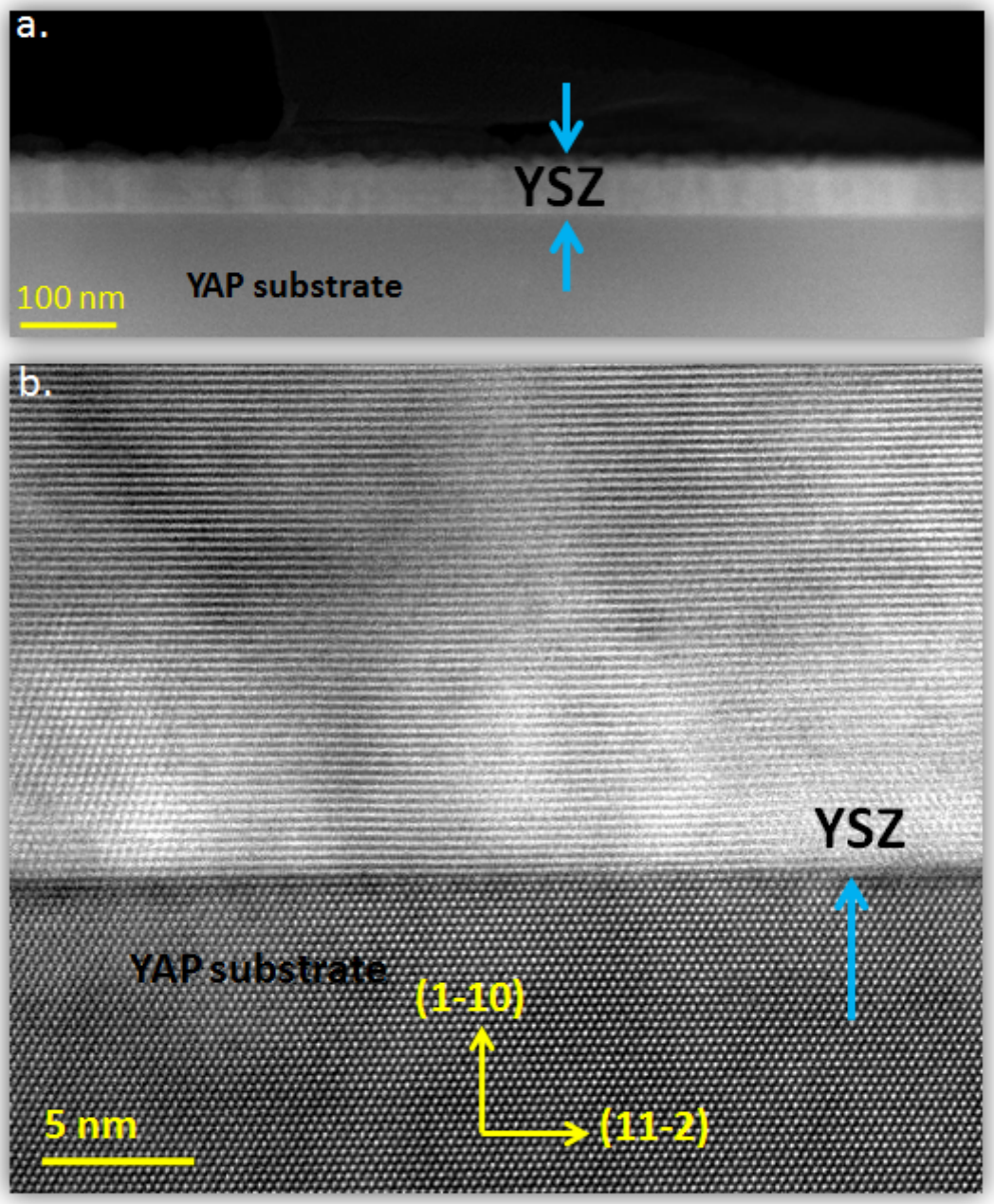

Fig. 1: Z-contrast STEM image of a 70 nm YSZ thin film with an amorphous YAP capping. The yellow arrows show the orientation of the substrate. a. Low magnification image of the thin film. b.High resolution image of the interface. Data acquired in a Nion UltraSTEM200, operated at 200 kV.