Structural, electronic and magnetic study of a single ultra-thin maghemite island.

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Iron oxides continue to fascinate us after nearly century of "modern" science devoted to their growth properties, and structures [1]. Recently, a revival of research has been spurred by the multiferroic character of maghemite, or its predicted half-metal character both interesting for spintronic applications. The possibility to fabricate oxides in metal films through hetero-epitaxy is helpful in several ways, first because a suite of standard surface science techniques is available for in-situ characterization, and second because epitaxy opens the door to tailoring materials properties through epitaxial strain, nano-scale self assembly, etc.
How the magnetic structure and electronic properties of iron oxides can be modified, or enhanced, in ultra-thin film form is the fundamental motivation behind this work.

We grow flat islands of maghemite on Ru(0001) by two step oxidation process. In the first step we perform the iron deposition in oxygen atmosphere in order to obtain magnetite triangle islands surrounded by a wüstite wetting layer [2]. The second step consists in the film exposition to a NO_2 pressure to promote the oxidation reaction [3]. This second process allows the oxidation of magnetite islands into maghemite while the wüstite wetting layer changes to hematite.

The islands growth has been followed by low-energy electron microscopy (LEEM). The maghemite islands, together with magnetite islands, have been characterized locally by X-ray photoemission (XPS) and absorption (XAS) in order to describe the electronic state and to study the oxidation reaction. The structure of the islands and the wetting layer has been identified by electron diffraction (LEED). Finally, X-ray circular dichroism has been performed in order to get information about the magnetic properties. All the analyses have been carried out on a single island using a synchrotron-based photoemission electron microscopy (XPEEM)

References

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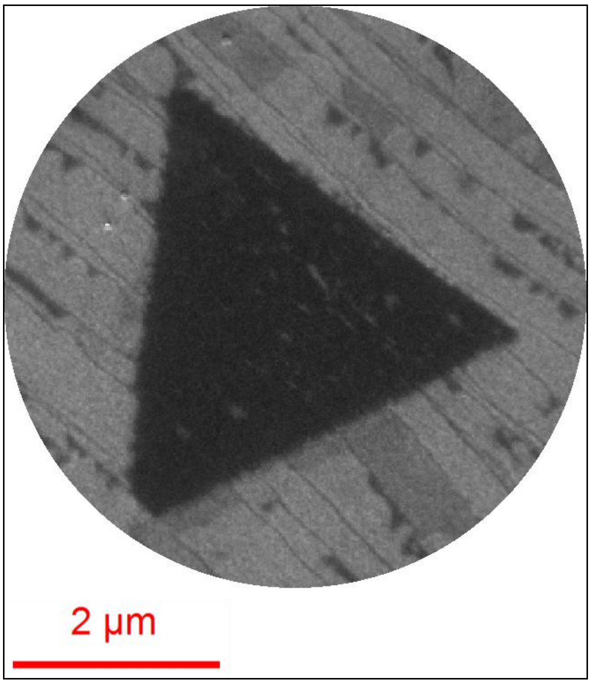
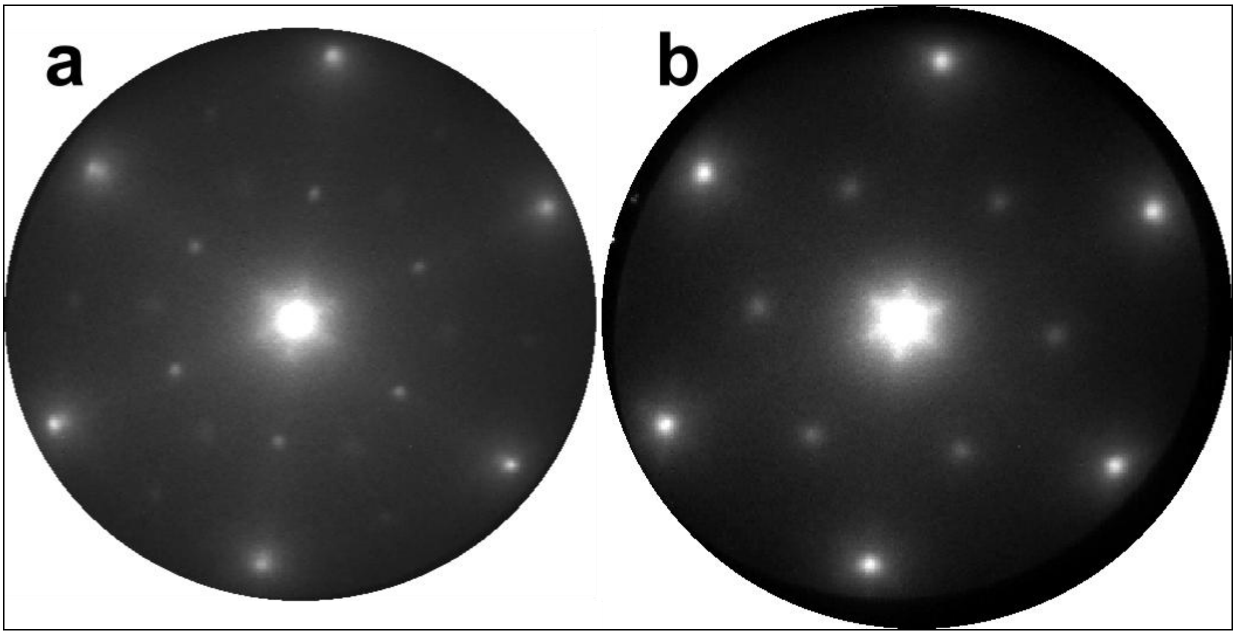
[2] S. Santos, E. Loginova, A. Mascaraque, A. Schmid, K. McCarty, and J. de la Figuera, J. Phys. Cond. Matt. 21 (2009).
[3] X. Deng and C. Matranga, Selective growth of Fe2O3 nanoparticles and islands on Au(111), J. Phys. Chem. C 2009, 113, 11104-11109.

Figures



Real space image of a single maghemite island. LEEM image 24eV.



Different reciprocal space images (30eV) of maghemite island (a) and hematite wetting layer (b).