Oxygen-assisted epitaxial growth of ultrathin films on Fe(001): from surfactant assisted growth to Fe supported ultrathin oxide films.

Picone,[1] G. Fratesi,[2] M. Riva,[1] G. Bussetti,[1] A. Calloni,[1] A. Brambilla,[1] M. I. Trioni,[3] L. Duò,[1] F. Ciccacci,[1] and M. Finazzi[1]
1CNISM - Dipartimento di Fisica, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italy
2Dipartimento di Scienza dei Materiali, Università di Milano-Bicocca, Via Cozzi 53, 20125 Milano, Italy
3CNR - Consiglio Nazionale della Ricerca, ISTM, via Golgi 19, I-20133 Milano Italy

Surfactant assisted growth is a well established procedure to obtain atomically flat ultrathin metallic films, both in heteroepitaxy and homoepitaxy. Small amounts of atoms adsorbed on a substrate prior to film deposition, such as for instance light elements like oxygen or heavy elements like Pb, have proven to be very effective in promoting layer by layer growth in systems that naturally grow in a three dimensional mode.

In the first part of this contribution it will be shown that, besides this scenario, also other possibilities can arise.

We consider Fe, Ni and Cr ultrathin films grown by means of Molecular Beam Epitaxy (MBE) on either the Fe(001) surface and on the oxygen passivated Fe(001)-p(1x1)O surface, characterized by one oxygen atom per surface unit cell [1]. Depending on the growth conditions, we find that oxygen can induce a rich variety of morphologies, such as for instance the development of spirals [2] or the nucleation of bilayer islands [3]. In addition, we find that oxygen assisted growth can also alter the chemical composition of the growing film, leading to the stabilization of ordered surface alloys.

The resulting structures are analyzed by means of Scanning Tunneling Microscopy and Spectroscopy (STM/STS), Low Energy Electron Diffraction (LEED), Auger Electron Spectroscopy (AES), with the help of Density Functional Theory calculations (DFT).

In the second part it is discussed the possibility to stabilize atomically flat films of transition metal oxides on Fe(001). In this case the goal is to investigate the possibility to obtain transition metal oxide/iron heterostructures characterized by sharp interfaces and atomically flat surfaces.

As a first step we consider Ni and Cr films deposited on the Fe(001)-p(1x1)O surface as model systems for the investigation of transition metal oxide/iron heterostructures. The strategy is to stabilize a single layer of oxide supported by metallic Fe by using the oxygen preloaded on the Fe(001)-p(1x1)O surface.

We find that it is not possible to wet the Fe(001) surface with a single layer of NiO, but perfectly ordered wetting layers of Cr-oxide can be obtained [4].

These preliminary results suggest that, also for thicker films, the Cr oxide/Fe structure could be an ideal candidate for the study of such systems with atomic scale precision.

[1] A. Picone, G. Fratesi, A. Brambilla, P. Sessi, F. Donati, S. Achilli, L. Maini, M. I. Trioni, C. S. Casari, M. Passoni, A. Li Bassi, M. Finazzi, L. Duò, and F. Ciccacci "Atomic corrugation in scanning tunneling microscopy images of the Fe(001)-*p*(1x1)O surface" Phys. Rev. B **81**, 115450 (2010).

[2] Calloni, A. Picone, A. Brambilla, M. Finazzi, L. Duò, and F. Ciccacci "Effects of temperature on the oxygen aided Cr growth on Fe(001)" Surf. Sci. **605**, 2092 (2011).

[3] A. Picone, G. Bussetti, M. Riva, A. Calloni, A. Brambilla, L. Duò, F. Ciccacci, and M. Finazzi "Oxygen-assisted Ni growth on Fe(001): Observation of an "anti-surfactant" effect" Phys. Rev. B **86**, 075465 (2012).

[4] A. Picone, G. Fratesi, M. Riva, G. Bussetti, A. Calloni, A. Brambilla, M. I. Trioni, L. Duò, F. Ciccacci, and M. Finazzi "Self-organized chromium oxide monolayers on Fe(001)" **accepted** by Phys. Rev. B (2013).