

Structure and magnetism in ultra-thin Fe films on Re (0001)

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The magnetic properties of ultrathin metallic films often deviate strongly from the bulk behavior due to the reduced coordination number of the surface atoms, with results as remarkable as the antiferromagnetic order observed in Fe, a prototypical ferromagnet [1]. Depending on temperature and pressure, iron can present three different equilibrium phases: the α -Fe phase which shows a BCC structure and ferromagnetism at RT, the γ -Fe phase exhibiting an FCC arrangement and can be ferromagnetic under certain conditions, and the ϵ -Fe phase with an HCP structure. The magnetism of this phase depends strongly on the structure and both ferromagnetic and non-magnetic ordering have been reported in previous works. Theoretical works have reported that ferromagnetism in HCP iron is possible for lattice parameters larger than 2.70 Å and non-magnetic or anti-ferromagnetism is possible for smaller lattice parameters [2], but both phases are almost degenerated in energy.

Here we present a morphological, structural, and magnetic characterization of Fe thin films [1-6 atomic layers (AL)] on Re (0001). The morphology and the growth mode of the films were studied by LEEM and LEED at two different temperatures ranges. Results show that at high temperatures it is possible to obtain a layer-by-layer growth up to the third layer. LEED and LEED-IV fits provided the crystalline structure of the films during the growth. The first Fe layer shows a hexagonal lattice and a hcp stacking sequence following the Re (0001). Second and thicker layers relax their lattice parameter to iron bulk. The magnetic characterization was carried out by both XMCD and XMLD-PEEM measurements. Contrary to recent STM reports [3], no anti-ferromagnetism was found for 1 or 2 AL. On the other hand, XMCD shows ferromagnetism for three or thicker layers.

References

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- [2] Zenia, H, et al. Surface Science 515, 245–25, (2002)
- [3] Ouazi, S. et al. Surface Science 630, 280–285, (2014)
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Figures

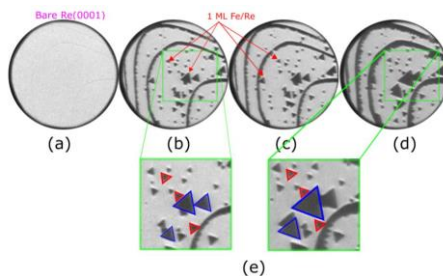


Figure 1: (a)–(d) LEEM images acquired during the nucleation of 1 AL Fe/Re(0001). Fe nucleates on Re as triangular islands with two different orientations in the same terrace. FOV is 10 μm .