Elucidating the magnetic behaviour of metastable Fe/Ni layers grown on top of the oxygen-reconstructed Fe(001) surface

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The growth of epitaxial Fe/Ni heterostructures offers the unique possibility of stabilizing unusual crystallographic phases, possibly characterized by novel electronic and magnetic properties.[1] From the fundamental point of view, the investigation of such systems aims at (i) elucidating the physics which comes into play during the formation of heterointerfaces and ultra-thin films and (ii) linking the structural and electronic characteristics to the magnetic response of such complex systems in terms, *e.g.*, of their magnetic coercivity and anisotropy.[2] Conversely, from the point of view of applications, magnetic nanostructures and novel magnetic phases are expected to rival the performances of more expensive rare earths-containing materials.[3]
We present a structural and spectroscopic characterization of ultra-thin Ni films grown on *bcc* Fe. At variance with previous literature investigations, the substrate is treated in order to form an oxygen superstructure, namely the Fe-p(1x1)O surface. The presence of an oxygen overlayer, capable of floating at the Ni/Fe sample surface even at room temperature, contributes to a peculiar morphological evolution and intervenes in the structural relaxation of the metastable Ni overlayer, as anticipated by our previous studies.[4] In the present work, we extend our investigation away from the Ni/Fe interface and focus on the magnetic behaviour of this system by the combined use of spin-resolved photoemission spectroscopy (SR-PES) and inverse photoemission spectroscopy (SR-IPES). A strong decrease in the surface polarization is observed with increasing thickness of the *bcc* Ni layer, with a clear quenching of the magnetization signal associated with specific surface features. The spectral spin-polarization typical of *bcc* Fe is then recovered by growing an additional ultra-thin Fe layer on top of Ni, all with no signs of surface relaxation, as testified by low energy electron diffraction (LEED). On the one hand, this observation suggests the possibility of applying our method to the growth of Fe/Ni multilayers with little or no structural evolution. On the other hand, given the abrupt onset of the Fe magnetization, observed even at monolayer coverage, we suggest that such Fe overlayer could be considered prototypical for the study of the magnetic behaviour of highly decoupled or nearly free-standing low-dimensional systems.[5]

References:

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