Strain, shape and magnetic anisotropies in ultrathin Fe films on GaAs (001)

O. Thomas  
TECSEN CNRS Université Aix-Marseille III, France  
And Dept MS&E, Cornell University, Ithaca NY, USA  
Q. Shen  
CHESS, Cornell University, Ithaca NY, USA  
A. Guivarch  
PALMS CNRS, Université de Rennes, France

The recent demonstration of spin injection through metal-semiconductor interfaces opens the way to a new class of electronic devices. Fe grows epitaxially on GaAs (001) with a cube-on-cube orientation and this is one of the most promising systems for spin injection devices. Below about 40 monolayers Fe films exhibit a uniaxial in-plane magnetic anisotropy with an easy axis along [110]. This early finding by Prinz\(^1\) has been confirmed since by many groups around the world. The debate about the origin of this anisotropy remains, however, unsettled. Above 40 monolayers the usual cubic anisotropy of bulk Fe is recovered with <100> as easy directions.

Fe films of varying thickness (1.5 to 13 nm) have been studied by grazing incidence x-ray diffraction at CHESS F3. The films were grown by molecular beam epitaxy on GaAs (001) (2x4) at room temperature. Reciprocal space maps and line scans indicate that structural anisotropies occur in these layers. Strain relaxation as well as coherent domain size are different along [110] and [1-10]. From the values of strains and domain sizes one can evaluate the corresponding magnetic free energy. The comparison with magnetic measurements (magneto-optic Kerr effect, Gradient field magnetometry) allows one to conclude unambiguously that the uniaxial magnetic anisotropy is related to the interfacial structure.