Epitaxial Cobalt-Ferrite Thin Films for Room Temperature Spin Filtering

Doctoral thesis defense

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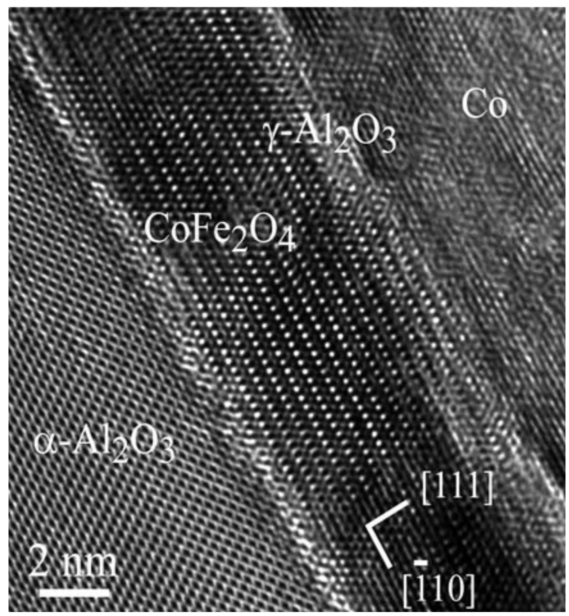

Remarkable progress in the growth of complex magnetic oxides has sparked renewed interest in physical phenomena traditionally inaccessible at room temperature. One prime example is spin filtering, which can potentially produce highly spin-polarized electron currents by the spin-selective transport of electrons across a magnetic tunnel barrier. Successful spin filtering at room temperature could significantly impact future generations of spin-based device technologies not only because spin filters may function with 100% efficiency, but because they may be combined with any non-magnetic metallic electrode, thus providing a versatile alternative to half metals or systems that require coherent spin-polarized tunneling. In this thesis, we present a complete study of the material cobalt ferrite ($CoFe_2O_4$), whose insulating behavior and high Curie temperature (793 K) make it a very good candidate for spin filtering at room temperature. $CoFe_2O_4$ thin films and associated multilayers were grown by oxygen plasma-assisted molecular beam epitaxy. Their structural, chemical and magnetic properties were studied by a number of *in situ* and *ex situ* characterization techniques, as these are known to significantly impact the spin filter capability of complex magnetic oxides. $CoFe_2O_4$-based spin filter tunnel junctions were then prepared for spin polarized tunneling experiments involving either the Meservey-Tedrow technique or tunneling magnetoresistance (TMR) measurements. In the case of the latter experiments, we also paid special attention to the magnetization reversal behavior of the $CoFe_2O_4$ spin filter barrier and its magnetic counter-electrode (Co or Fe_3O_4), which was a crucial step towards the successful measurement of TMR. In both cases, spin polarized transport measurements reveal significant spin polarization of the tunneling current at low temperature, and at room temperature in the case of the TMR. In addition, the TMR ratio follows a unique bias dependence that has been theoretically predicted to be the signature of spin filtering in magnetic tunnel barriers. We therefore show that $CoFe_2O_4$ tunnel barriers provide a model system to investigate spin filtering in a wide range of temperatures.