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Indirect spin current depolarization from interfacial roughness for EuO based magnetic tunnel junctions

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The spin filtering effect and high degree of spin-polarization [1] in the tunneling current observed in EuO based magnetic tunneling junctions makes this system an ideal candidate for building spintronic devices. The thickness of the ferromagnetic barrier and the electrodes used affect the measured polarization considerably. We present work on EuO wedge samples with Ag, Al, and Y electrodes to identify the contribution of interfacial roughness and intermixing at the interfaces using XAS and XRS (X-ray Resonant Scattering). These element specific techniques are ideal probes for studying the structural and chemical composition of surfaces and buried interfaces. We used the specific XAS signature of EuO and Eu₂O₃ (a non-magnetic stable oxide of europium) to quantify the amount of the different oxides as a function of either the EuO film thickness or the electrode thickness. Yttrium electrodes are by far the best oxygen barriers and preserve the integrity and quality of the EuO film. Roughness parameters extracted from diffuse XRS scans show that thinner EuO films with a 20 Å Y electrode are smooth (5 Å rms roughness). With increasing EuO thickness, the rms roughness increases significantly and the fraction of the film converted to Eu₂O₃ is found to increase. In Ag and Al electrodes, however, the fraction of the film present as Eu₂O₃ is found to decrease with increasing EuO thickness. We conclude that for Y electrodes, the formation of Eu₂O₃, facilitated by the interfacial roughness, is responsible for the significant reduction (about 60%) in the measured spin-polarization of the tunneling current.

[1] T.S. Santos and J. S. Moodera, Phys. Rev. B, 69, 241203 (2004)