The Spin Polarization of Metals on Magneto-Electric Cr_2O_3

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The surface region, especially as the surface/interface, is essential to successful magneto-electric devices [1]. We have investigated palladium (Pd) on the magneto-electric chromia, Cr_2O_3, using spin polarized inverse photoemission spectroscopy (SPIPES), as well as spin polarized photoemission (SPES) technique. This effort has provided insight into both the unoccupied and occupied states in the vicinity of the chemical potential, in manner then helps elucidate spintronic properties of this magneto-electric bilayer structure. The hugely surface sensitive nature of SPIPES is an advantage for characterizing boundary polarization. This is important because Pd on Cr_2O_3 is the foundation to working voltage controlled anomalous Hall spintronic memory devices [2]. These devices are very forgiving in terms of the Pd overlayer thickness, inconsistent with mean field models where the induced polarization in the Pd layer decays with a characteristic decay length associated with the Pd paramagnetic correlation length.

In fact, we have evidence of persistent spin polarization of Pd overlayer on Cr_2O_3. In addition, the polarization near the bottom of the conduction band reversing sign at very thin Pd overlayer thicknesses consistent with exchange coupled devices made with a ferromagnet with, perpendicular anisotropy, coupled to chromia through a Pd spacer layer. The results show evidence of magnetic behavior suggesting that Pd on Cr_2O_3 is more than just a paramagnetic with an induced polarization arising from the chromia boundary polarization.

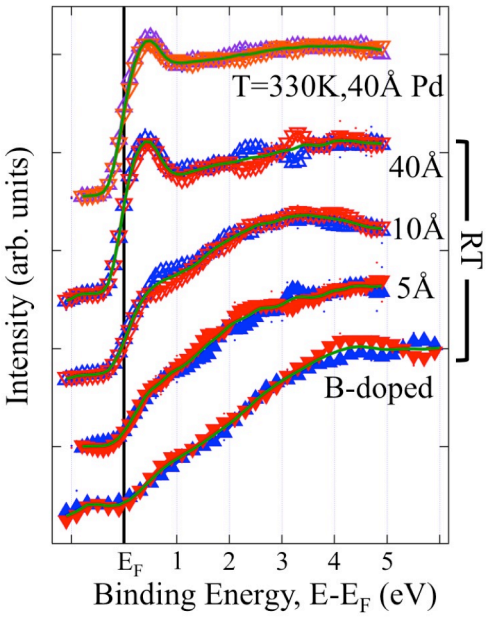

Figure. Experimental SPIPES of Pd overlayer thickness dependence on Cr_2O_3, at room temp. (RT), (bottom 4 spectra) and T=330 K (at top). Spin up (majority) is in blue, with upward triangles, and spin down (minority) is in red, with downward triangles. The boron (B) doped Cr_2O_3 spectrum, without an adlayer, is at the bottom.

[1] P. A. Dowben, C. Binek, and D. E. Nikonov, Chapter 11 in *Nanoscale Silicon Devices*; edited by Shuni Oda and David Ferry; Taylor and Francis (London) (2016) pp 255-278
[2] T. Kosub, M. Kopte, R. Hühne, P. Appel, B. Shields, P. Maletinsky, R. Hübner, M. O. Liedke, J. Fassbender, O. G. Schmidt, D. Makarov, Nature Comm. 8, 13985 (2017)