Highlights

Oxides —2017

Quantifying the critical thickness of electron hybridization in spintronics materials

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NATURE COMMUNICATIONS 8, 16051 (2017)

In the rapidly growing field of spintronics, simultaneous control of electronic and magnetic properties is essential, and the perspective of building novel phases is directly linked to the control of tuning parameters, for example, thickness and doping. Looking at the relevant effects in interface-driven spintronics, the reduced symmetry at a surface and interface corresponds to a severe modification of the overlap of electron orbitals, that is, to a change of electron hybridization. Here we report a chemically and magnetically sensitive depth-dependent analysis of two paradigmatic systems, namely $La_{1-x}Sr_xMnO_3$ and (Ga,Mn)As. Supported by cluster calculations, we find a crossover between surface and bulk in the electron hybridization/correlation and we identify a spectroscopic fingerprint of bulk metallic character and ferromagnetism versus depth. The critical thickness and the gradient of hybridization are measured, setting an intrinsic limit of 3 and 10 unit cells from the surface, respectively, for (Ga,Mn)As and $La_{1-x}Sr_xMnO_3$, for fully restoring bulk properties.

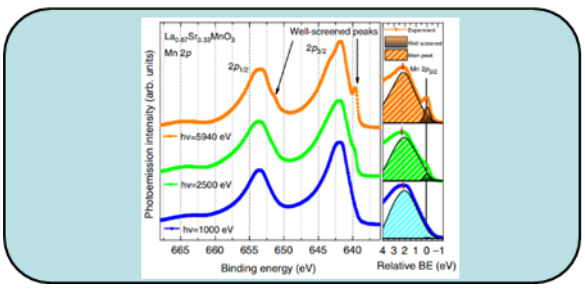

Fig.1: Photoemission Mn 2p spectra collected at different photon energies with different probing depth

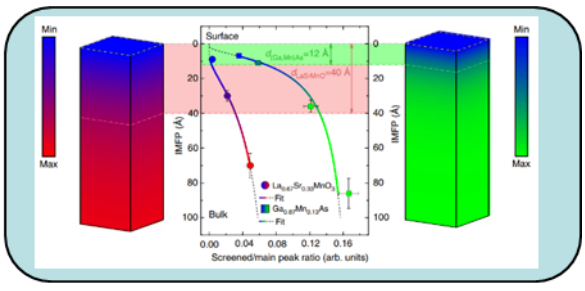

Fig.2: Estimated thickness of the surface region with altered electronic properties for the case of $La_{1-x}Sr_xMnO_3$ and (Ga,Mn)As