Spin Polarization in $Co/Al_2O_3/Co$ Tunnel Junctions

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Spin-dependent tunneling in magnetic tunnel junctions garnered much attention due to possible applications in non-volatile random access memories and next-generation magnetic field sensors. Using first-principles calculations and quantum theory of transport we study spin-dependent tunneling in industrially important $Co/Al_2O_3/Co$ tunnel junctions. We demonstrate that the spin polarization in these junctions is controlled by the interfacial structure and bonding and that adsorption of oxygen by the Co surface may be a prerequisite for the positive spin polarization. The sensitivity of the spin polarization to the interface structure and bonding broadens dramatically the possibilities to engineer magnetic tunnel junctions with properties desirable for device applications.

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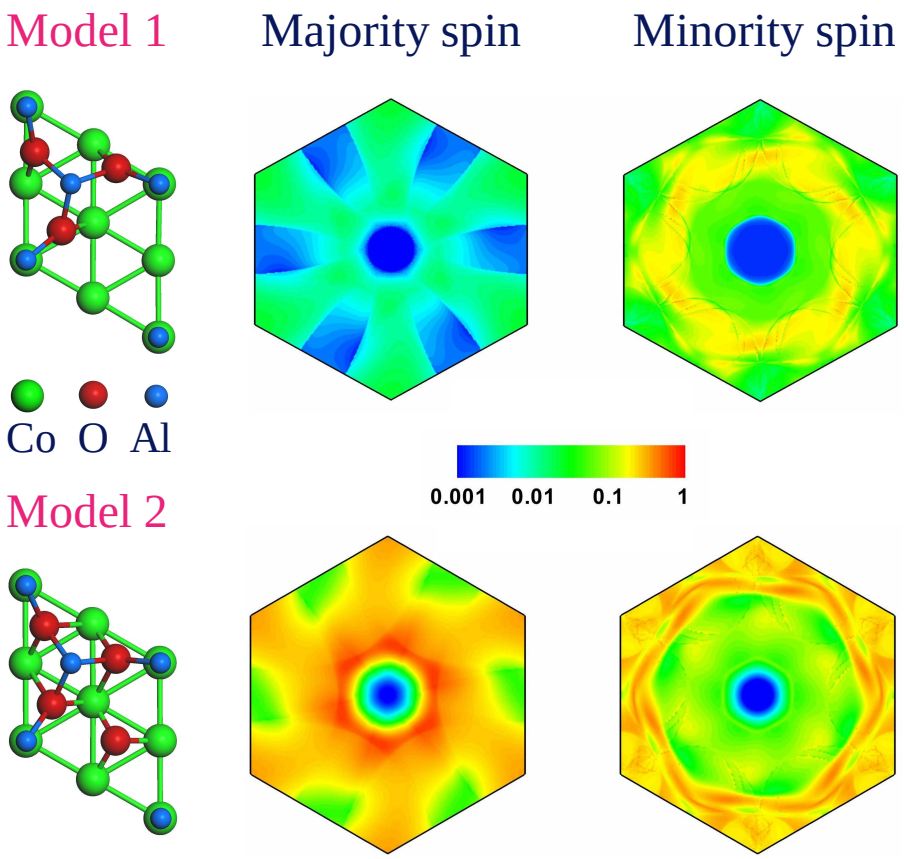

Relaxed interface atomic structure and $\mathbf{k}_{||}$-resolved spin-dependent conductance for two models of a $Co/Al_2O_3/Co$ tunnel junction. The presence of the "adsorbed" O atom in Model 2 leads to the significant (20 fold) enhancement of the conductance in the majority-spin channel, which makes the spin polarization positive in agreement with experimental observations.