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Interface Controlled Tunneling Spin Polarization[1]

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In recent years spin-dependent tunneling in magnetic tunnel junctions has aroused enormous interest and developed into a vigorous field of research. However, despite extensive efforts to elucidate the mechanisms of spin-dependent tunneling, a complete understanding of this phenomenon is still lacking. In this talk we will consider various factors controlling the spin polarization of the tunneling current and emphasize the decisive role of interface bonding. We will show that the tunneling spin polarization is primarily determined by the electronic and atomic structure of ferromagnet/insulator interfaces rather than bulk properties. Starting from a simple tight-binding model which demonstrates the importance of interface states that are controlled by the hybridization between the atoms at the interface, we will, then, consider spin-dependent tunneling from the oxidized Co surface through vacuum [1] and in $Co/Al_2O_3/Co$ tunnel junctions [2], where the cobalt-oxygen bonding at the interfaces play a crucial role. Our results indicate that the common argument of the dominant s-electron tunneling which is often used to explain positive values of the spin polarization in alumina-based tunnel junctions might be qualitatively incorrect. Moreover, oxygen atoms adsorbed by cobalt at the Co/Al_2O_3 interface may be a prerequisite for the positive spin polarization. The importance of the interface bonding and structure in spin-dependent tunneling makes the quantitative description of transport characteristics much more complicated; however, it broadens dramatically the possibility to engineer magnetic tunnel junctions with properties desirable for device applications. [1] K.D. Belashchenko, E.Y. Tsymbal, M. van Schilfgaarde, D. Stewart, I.I. Oleynik, and S.S. Jaswal, Phys. Rev. B 69, 174408 (2004). [2] K.D. Belashchenko, E.Y. Tsymbal, I.I. Oleynik, and M. van Schilfgaarde, submitted paper.

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