Interfacial Exchange Coupling in Oxide Superlattices

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Abstract:

Interfacial exchange coupling in hetero-structures, engineered in atomic scale is an essential feature of modern electronic devices and to explore the intriguing spin physics. The designed interfaces of superlattices integrated by strongly co-related oxides have been the playground for probing numerous functionalities. In this talk, I will be focussing on several interesting coupled interfacial phenomena and its tunability in the superlattices consisting of two ferromagnets, $SrRuO_3$ and $PrMnO_3$. The interfacial bi-axial strain modifies the oxygen octahedra rotation and induces the orthorhombic to tetragonal crystal symmetry transformation by increasing the $PrMnO_3$ layer thickness from 0.385 nm to 1.1 nm. The interplay of stronger anti-ferromagnetic coupling energy and Zeeman energy leads to the crossover from negative to positive exchange bias in tetragonal superlattices. While, the stronger spin-orbit coupling and relatively weaker exchange coupling in orthorhombic superlattices are responsible for the vertical shift of the hysteresis loop. The exchange coupling strength tuned by the size of $PrMnO_3$ layer in ultra-thin scale leads to a rise of magnetic anisotropic energy from $0.28 \times 10^6\ erg/cm^3$ to $1.60 \times 10^6\ erg/cm^3$. The size effect is also used as a tool to control the rarely observed anomalous features in anisotropic magneto-resistance hysteric. Our investigations demonstrate that the technologically important interfacial magnetic coupling, perpendicular magnetic anisotropy, positive magneto-resistance in spintronics based devices could be achieved and precisely manipulated in a periodically stacked bilayer.

Ref: A. Sahoo, P. Padhan and W. Prellier, ACS Appl. Mater. Interfaces 9, 36423-36430 (2017).