TRANSFORMATION OF SPIN INFORMATION INTO LARGE ELECTRICAL SIGNALS USING CARBON NANOTUBES

Neil D Mathur

Department of Materials Science, University of Cambridge,

Pembroke Street, Cambridge CB2 3QZ, UK

Spin electronics (spintronics) exploits the magnetic nature of the electron, and is commercially exploited in the spin valves of disc-drive read heads. There is currently widespread interest in using industrially relevant semiconductors in new types of spintronic devices based on the transport of a spin current in a lateral semiconducting channel between a spin-polarized source and drain. However, the transformation of spin information into large electrical signals is limited by spin relaxation such that the magnetoresistive signals are below 1%. This long-standing problem in spintronics is overcome by demonstrating large magnetoresistance effects of 61% at 5 K in devices where the non-magnetic channel is a multiwall carbon nanotube that spans a 1.5 μm gap between epitaxial electrodes of the highly spin polarized manganite $La_{0.7}Sr_{0.3}MnO_3$. This improvement permits large output signals of 65 mV, and arises because the spin lifetime in nanotubes is long due the small spin-orbit coupling of carbon, because the high nanotube Fermi velocity permits the carrier dwell time to not significantly exceed this spin lifetime, because the manganite remains highly spin polarized up to the manganite-nanotube interface, and because the interfacial barrier is of an appropriate height. These latter statements regarding the interface are supported using density functional theory calculations. The success of these experiments with such chemically and geometrically different materials should inspire adventure in materials selection for some future spintronics.

LE Hueso, JMA Pruneda, V Ferrari, G Burnell, JP Valdés-Herrera, BD Simons, PB Littlewood, E Artacho, A Fert and ND Mathur, *Nature* **445** (2007) 410