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A new twist on organic spintronics: Controlling transport in organic sandwich devices using fringe fields from ferromagnetic films[1]

MARKUS WOHLGENANNT, University of Iowa, Department of Physics and Astronomy

Organic spintronics studies the physics of spin-injection and magnetic-field dependent transport phenomena in organic semiconductors, possibly leading to devices with added functionality. So far, studies have focused on spin-valve architectures as well as entirely non-magnetic devices that nevertheless show large room-temperature magnetoresistance through the so-called organic magnetoresistive effect. We demonstrate a new method of controlling the electrical conductivity of an organic film at room temperature, using the spatially-varying magnetic fringe fields of a magnetically-unsaturated ferromagnet. A large variation from hopping site to hopping site of the nuclear hyperfine field is known to dramatically affect electronic transport in organics, whose resistances are very sensitive to small applied magnetic fields, so the ferromagnet's fringe fields might act as a substitute either for the applied magnetic field or for the inhomogeneous hyperfine field. The size of the effect, magnetic field dependence, and hysteretic properties rule out a model where the fringe fields from the ferromagnet provide a local magnetic field that changes the electronic transport properties through the hyperfine field, and show our effects originate from electrical transport through the inhomogeneous fringe fields coming from the ferromagnet. Surprisingly these inhomogeneous fringe fields vary over length scales roughly two orders of magnitude larger than the hopping length in the organic materials, challenging the fundamental models of magnetoresistance in organic layers which require the correlation length of the inhomogeneous field to correspond roughly to the hopping length. Our devices, which do not rely on spin injection, tunneling anisotropic magnetoresistance or spin-valve behavior, may provide a simple approach to integrating magnetic metals and organics for hybrid spintronic devices. These devices may find application as high-voltage readouts of the magnetic state of low-impedance ferromagnetic films.

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