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Influence of spin polarized current on superconductivity and spin transport in organic semiconductors[1]

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Spin conserved tunneling from a ferromagnetic (FM) electrode through an insulating barrier with a superconductor as the spin detector, was discovered by Meservey and Tedrow three decades ago. This phenomenon of spin polarized tunneling has been successfully utilized to understand many aspects of magnetism and superconductivity. In recent years enormous success is seen in magnetic tunnel junctions both from the fundamental viewpoint as well as due to their application in information technology. In general, BCS superconductivity with Cooper pairs formed at the Fermi level with electrons of opposite spins is not compatible with ferromagnetism which have parallel spin configuration. The superconducting state can be influenced by injecting spin polarized current in a controlled manner by properly tailoring the interfacial transmittivity between a ferromagnet (F) and a superconductor (S), resulting in a large magnetoresistance (MR) of over 1100% for a F/I/S/I/F multilayer system (I - insulator) or even infinite MR can be achieved in epitaxial metallic systems. Due to the competition between ferromagnetism and superconductivity, the superconducting transition temperature (T_C) in the spin parallel configuration is shifted below that of the spin anti-parallel configuration. This T_C shift can much larger than that predicted by theories. Oscillation in Tc is also observed. The field is the spin transport properties in organic semiconductors (OSs), a least explored area. Because OSs are composed of mostly light elements (i.e. C, H, N, O) and thus have a weaker spin-orbit interaction, low hyperfine interactions, spin coherence lengths can be long in these materials. Large spin decay length was observed in amorphous Rubrene. Recent developments in electron spin polarized tunneling through ultrathin layers of the molecular organic semiconductors such as Alq3 and Rubrene will be discussed.

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