Materials Science and Technology Division

"Strong bias dependence and magnetic anisotropy of ferromagnet/semiconductor tunnel junctions"

Athanasios Chantis
Los Alamos National Laboratory

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Abstract:

Recent experiments have established that the electrical spin injection and detection with ferromagnet/semiconductor Schottky tunnel barriers exhibits strong bias dependence [1,2]. In this talk I will describe our theoretical study related to these experiments. Using a combination of first-principles electronic structure methods and theoretical modeling we have shown that the bias-dependence originates from two distinct physical mechanisms: (a) the bias dependence of electron spin-dependent tunneling, which is of microscopic origin and depends on the specific properties of the interface [3], and (b) the macroscopic electron-spin transport properties in the semiconductor [4]. With the help of the fully relativistic first-principles layer Green's function code that we developed, we show that the first mechanism can also lead to a sizable tunneling anisotropic magnetoresistance in magnetic tunnel junctions with a single magnetic electrode [5]. These theoretical predictions are found to be in good agreement with recent experiments [6] and are of great interest to researchers in the area of spintronics, magnetism and electron transport in semiconductors.

1. Nature Phys. 3, 197 (2007)
2. Phys. Rev. B 80, 041305 (2009)
3. Phys. Rev. Lett. 99, 196603 (2007)
4. Phys. Rev. B 78, 235317 (2008)
5. Phys. Rev. Lett. 98, 046601 (2007)
6. Phys. Rev. Lett. 99, 056601 (2007)

Host: David Singh (241-1944, singhdj@ornl.gov)