Advances in the use of a spin-polarized metastable helium beam to characterize surface magnetic properties

Andrew Pratt
ICYS Sengen

Here we give an overview of the use of a spin-polarized beam of metastable (2^3S) helium atoms to characterize surface magnetic properties, especially those of materials relevant to future technological devices. Surface properties are often vastly different to the bulk of a material due to reduced dimensionality, unsaturated dangling bonds and relaxation and reconstruction of the bulk atomic structure. Hence, their understanding is critical to the design and operation of, for example, spintronic and molecular spintronic devices. In particular, the role of surface and interfacial states in determining the efficiency of spin injection from a ferromagnetic (FM) metal into a non-magnetic solid has recently become increasingly clear [1].

When approaching a surface to within several angstroms, helium atoms, prepared in the long-lived metastable 2^3S state (E_{He*} = 19.82 eV), may lose their energy via several de-excitation mechanisms (see figure). This causes the emission of an electron which carries with it information on the surface electronic and magnetic properties. As the cross-section for this de-excitation is so large, there is no penetration of the atom below the topmost surface whatsoever. The technique becomes magnetically active by electron-spin-polarizing the He 2^3S atoms to provide an extremely sensitive probe of the spin-resolved densities of state at the surface of a material [2,3].

In this talk, recent progress on the implementation of this technique will be given concentrating on the characterization of materials relevant to spintronic and molecular spintronic devices, for example the spin polarization at the surface of FM oxides [4,5] and organic semiconductor-FM interfaces [6,7].

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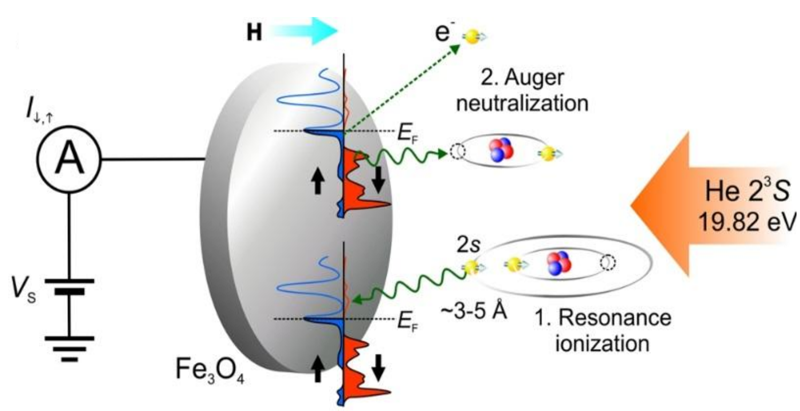

Schematic of He 2^3S de-excitation at a ferromagnetic surface and the sample current method used to probe the spin-resolved density of states. De-excitation at the conducting Fe_3O_4 surface occurs via the two-stage process of resonance ionization followed by Auger neutralization.