Single Molecule Magnet Characterization Using Spin Polarized Tunneling Spectroscopy and Kondo Resonance

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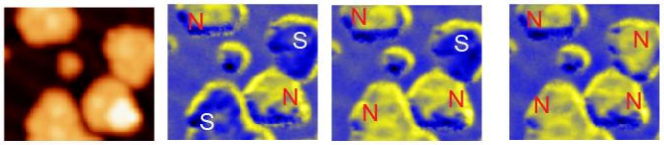
Nanostructures with perpendicular magnetic anisotropy are essential for realizing faster and smaller bits in magnetic memory devices. Magnetic characterization of such nanostructures with atomic resolution is highly desirable. In the first section of this talk, we report on the magnetization reversal of nanosized, bilayer cobalt islands on Au(111) using low temperature spin-polarized scanning tunneling microscopy. Cobalt nanoislands exhibit spontaneous out-of-plane magnetization which is manifested in a two-level contrast in the differential conductance maps. The two levels of contrast correspond to the parallel or anti-parallel alignment of the islands with respect to the out-of-plane component of the tip magnetization. An external magnetic field applied perpendicular to the sample surface changes the magnetization state of the cobalt islands. A series of maps taken at different magnetic field values allow us to extract the dI/dV hysteresis loop on individual cobalt islands (see Fig.1)

Second, we apply this technique to magnetic molecules, which attract attentions as a material for spintronic and quantum information process devices. A single molecule magnet (SMM), which is a class of molecule where a single molecule behaves as a magnet, is a good candidate for such an application. Bis(phthalocyaninato)terbium(III) complex ($TbPc_2$) molecule is a SMM molecule with a operation temperature higher than ~20 K. Due to the nature of Tb atom to be +3 cation and the two phthalocyanines (Pc's) both to be −2 anion, the neutral $TbPc_2$ has a π radical spin in addition to the Tb 4f spin of J = 6. In this study we study the spin behavior of the $TbPc_2$ molecule adsorbed on Co/Au(111) surface by using spin polarized (SP) STM. We examine the alignment of the molecule spin in the surface normal direction. We first confirm the spin-polarized tip condition by examining the two-level contrast originated from the parallel and antiparallel alignment of Co island spin with a respect to out-of-plane component of the magnetization of the tip. With using this tip, we observe the spin contrast of the TbPc2 molecule by measuring dI/dV mapping image at V_s = −300 mV. In Fig. 2 we show the results obtained at B = +1 T (a), and −1 T (b).

REFERENCES: Mishra et al., *Nano Lett.* **17**, 5843 (2017); Komeda et al., *Nat Commun* **2**, 217 (2011); T. Komeda et al., *ACS Nano* **7**, 1092 (2013); T. Komeda et al., *ACS Nano* **8**, 4866 (2014); F. Wu et al., *Nat. Comm.* **6**, 7547 (2015).

Fig. 1



STM-topo 2.5 T 3.0 T 3.5 T

Fig. 2

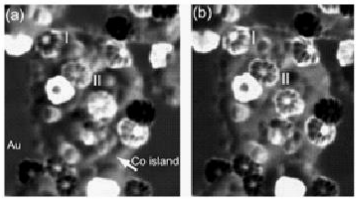


Fig. 1. Magnetization reversal of cobalt islands on Au (111). STM-topo image showing cobalt islands on Au (111). SP-dI/dV maps at V = -1 V of the same region at magnetic fields specified in the label.

Fig. 2. SP-STM obtained magnetic field of +1 T (a), and -1 T(b). SMM TbPc2 molecules at I and II show spin contrast.