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Beller Lectureship: Single Molecular Magnets on Conductive Surfaces[1]

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For more than a decade molecules showing magnetic bistability, generally known as Single Molecule Magnets, have represented a playground to study quantum effects that appear in magnetism when the nanometer scale is attained. The field is now mature to investigate more complex nanostructures where the interplay between transport and magnetism at the molecular scale can be exploited. The first step along this direction requires to organize SMMs on surfaces rather than as bulk phases. Pursuing this apparently straight forward task has already encountered many difficulties because of the complex nature and fragility of SMMs and of the peculiar origin of their magnetic bistability. Also robust SMMs based on lanthanide ions and phthalocyanine loose most of their SMM properties when the crystalline phase is abandoned. Thanks to a collaboration with Prof. Cornia in Modena, Italy, and Prof. Sainctavit in Paris, France, we have carried out a very low temperature synchrotron investigation showing that a polynuclear SMM cluster, based on a propeller-like tetranuclear iron(III) core, Fe4, retains the typical hysteresis also when the molecules are chemically grafted to a gold surface. The tailoring of the anchoring ligand has allowed the control of the orientation of the molecules on the substrate and has given the possibility to observe the resonant quantum tunneling of the magnetization. Preliminary investigations on Fe4 SMMs thermally evaporated in UHV conditions on a conducting ferromagnetic oxide like Lanthanium Strontium Manganite, have shown an unprecedented phenomenon. While the reported studies of paramagnetic molecules on magnetic substrates have in general shown a sizeable magnetic interaction with the substrate but no evidences of SMM behavior, in our investigation the magnetic hysteresis of Fe4 exceeds in coercive field that of the substrate, recorded at the Mn L3 edge. More interestingly, the zero field step of the hysteresis, typical of quantum tunneling of magnetization that characterizes Fe4 SMMs, disappears when deposited on LSMO, opening the perspective of a novel hybrid magnetism at the nanoscale.

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