Modifying the spin crossover transition of a molecular layer by epitaxial and oriented growth

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Abstract:

Spin crossover (SCO) molecules present two spin states that can be controlled by external stimuli such as light or temperature. Their ability to switch makes them promising candidates for incorporation in molecular spintronic devices. In this purpose, it is mandatory to understand how the properties of spin crossover molecules are modified when in direct contact with metallic substrates and how the growth of molecular films is governed by the substrate. Additionally, the bistability, i.e. the ability to reversibly switch between two stable states in the hysteretic temperature range, is an important property that needs to be controlled at the nanoscale.

Grazing incidence x-ray diffraction measurements on monolayer of $Fe[HB(3,5\text{-}(CH3)_2Pz)_3]_2$ (Pz=pyrazolyl) adsorbed on Au(111) and Cu(111) substrates enabled us to evidence that an epitaxial relationship between the molecular layer and the substrates exists (1). This has a direct consequence on the conversion from one spin-state to the other either by using temperature (2,3) light (4,5) or electric field (6) as external stimuli. Here, we will discuss in detailed the molecular structure of $Fe[HB(3,5\text{-}Me2Pz)_3]_2$ ultra-thin films adsorbed on Cu(110). For sub-monolayer coverage, the molecules form a perfectly epitaxial network on the Cu(110) substrate. For larger thicknesses, the film evolves due to the release of the epitaxial strain. Interestingly, the thicker molecular film structure resembles the one of the bulk molecular crystal with a growth along the (100) plane. By XAS measurements, we demonstrated that for a one-monolayer-high layer, the molecules are locked in the high spin state; while for a six-monolayer-high layer the molecules recovered their spin-crossover properties.

References:

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