Robust spin crossover and memristance across a single molecule

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The wish to increase the actual storage density leads to the research of nano-scale devices with different deterministic and stable states. The reading of the information should be done as easily as possible, and thus, memristive devices are good candidates. By using single molecules it is possible, in principle, to craft systems with an ideal balance between the robustness of the memory's state against environmental excitations and the ease to write the information. This ideal balance enables the down-sizing of the memory unit. In our work, the molecular-memristive-memory candidate is \( \text{Fe}(\text{1,10-phenanthroline})_2(\text{NCS})_2 \) (FePhen), a spin crossover (SCO) complex consisting of organic ligands around a transition metal ion known to be switchable between a high- and a low-spin state by external stimuli [1].

When deposited onto Cu(001), we find that both spin species of FePhen molecules coexist at low temperatures as deduced from spectroscopic STM data at 4K, and as supported by complementary x-ray absorption spectroscopy experiments. While on bare Cu(100), the molecules cannot be electrically switched between the two spin states using the STM tip, molecules on CuN can individually and reproducibly be switched between a high-spin, high-conduction state and a low-spin, low-conduction state by applying a small voltage pulse. This difference is explained by the role of the CuN layer as means to decouple the molecules from the metallic surface [2].

This robust and selective molecular system can be the base of a binary memristive memory, and, when integrated alongside a molecular spin injector/analyzer [3], could lead to 4-state molecular memory devices as a nanoscale counterpart to micronic devices with equivalent functionality [4].