# 08 : Electromigration technique to fabricate a single-molecule transistor

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With the comtemporary evolution of two disciplines, spintronics and molecular electronics, we now consider molecular electronics as a breakthrough. A fundamental link between these two fields can be established using molecular magnetic materials and, in particular, single-molecule magnets, which combine the classic macroscale properties of a magnet with the quantum properties of a nanoscale entity. The resulting field, molecular spintronics aims at manipulating spins and charges in electronic devices containing one or more molecules. The main advantage is that the weak spin-orbit and hyperfine interactions in organic molecules suggest that spin-coherence may be preserved over time and distance much longer than in conventional metals or semiconductors. In addition, specific functions (e.g. switchability with light, electric field etc.) could be directly integrated into the molecule.

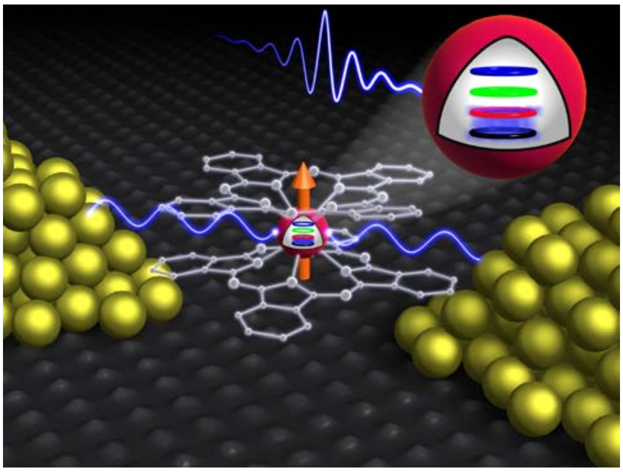

Figure: Artist's view of a nuclear spin qubit transistor based on a single $TbPc_2$ molecular magnet. The molecule, consisting of a single $Tb^{3+}$ ion (pink) sandwiched between two Pc-ligands (white) is coupled to source, drain and gate electrodes. The four anisotropic nuclear spin states of the (colored circles) can be manipulated with electric field pulses.

In this context, we propose to fabricate, characterize and study molecular devices (molecular spin-transistor, molecular spin-valve and spin filter, molecular double-dot devices, carbon nanotube, nano-SQUIDs, etc.) in order to read and manipulate the spin states of the single molecule device and to perform basic quantum operations.

The experimental part will be devoted to the fabrication of a single-molecule transistor by realizing a nanogap, using the real-time electromigration technique. Caractherization of the single-molecule transistor will be performed in a 4 K probe station. This practical gives insights about molecular deposition, nanofabrication, electromigration, and quantum transport at low temperature.