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Toward single atom qubits on a surface: Pump-probe spectroscopy and electrically-driven spin resonance
WILLIAM PAUL, IBM Research - Almaden

We will discuss the characterization of spin dynamics by pump-probe spectroscopy and the use of gigahertz-frequency electric fields to drive spin resonance of a Fe atom on a MgO/Ag(001) surface. In the spirit of this session, the technical challenges in applying a precise voltage to the tip sample junction across a wide radio-frequency bandwidth will be described. The energy relaxation time, T1, of single spins on surfaces can be measured by spin-polarized pump-probe STM (scanning tunneling microscopy) [1]. To date, the relaxation times reported for Fe-Cu dimers on Cu₂N insulating films have been of the order ~ 100 ns [1]. A three-order-of-magnitude enhancement of lifetime, to ~ 200 μ s, was recently demonstrated for Co on a single-monolayer of MgO [2]. Here, we report on the tailoring of the T1 lifetime of single Fe atoms on single- and multi-layer MgO films grown on Ag(001). Next, we demonstrate electron spin resonance of an individual single Fe atom, driven by a gigahertz-frequency electric field applied across the tip-sample junction, and detected by a spin-polarized tunneling current. The principle parameters of the spin resonance experiment, namely the phase coherence time T2 and the Rabi rate, are characterized for Fe atoms adsorbed to the monolayer MgO film. [1] Loth et al., Science 329, 1628 (2010) [2] Rau and Baumann et al., Science 344, 988 (2014) [3] Baumann and Paul et al., Science 350, 417 (2015)