Spin filtering on demand via localized states in an atomic-scale resonant tunneling magnetic tunnel junction

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Spin filtering and its back-action spin transfer torque (STT) are key ingredients of latest spintronic devices based on magnetic tunnel junctions (MTJs). Resonant tunneling (RT), implemented by design or occurring as parasitic effects, is known to crucially affect macroscopic device performance, but direct experimental access to its individual microscopic processes has remained difficult. Here we apply the RT scheme from MTJs to spin-polarized scanning tunneling microscopy (SP-STM) for ultimate miniaturization obtained by addressing individual nanomagnets. Combined with energy selectivity, our experimental model set-up enables to study the spin filtering capabilities of RT through an individual spin-split vacuum resonance state and of the corresponding STT excerted on the nanomagnet. We find, that the sign and magnitude of the STT follow the effective spin-polarization of the resonance state, which, as we show, can by tailored on demand either by adjusting the applied bias or the current injection point on the nanostructure. We anticipate, that our atomic-scale RT-MTJ approach and the discovery of a versatile tunable spin-filter at smallest scale will prove invaluable for studying and designing next generation MTJs potentially based on recently discovered 2D van-der-Waals magnets or altermagnets.