Physics of Nanomagnetism revealed by Spin-Polarized Scanning Tunneling Spectroscopy

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In order to probe and tailor magnetic properties at the spatial limit we have combined the scanning tunneling microscope (STM) with spin-sensitivity [1-3]. This is achieved by the use of ferro- [4-6] and antiferromagnetically [7,8] coated probe tips offering a high degree of spin-polarization of the electronic states involved in the tunneling process. Spin-polarized Scanning Tunneling Microscopy (SP-STM) and Spectroscopy (SP-STS) has allowed the visualization of atomic-scale spin structures [2,9] and the investigation of the spin-dependent local density of states spatially resolved [10]. Magnetic domain imaging with sub-nanometer-scale spatial resolution has been demonstrated for magnetic transition metal as well as rare earth metal films. Ultra-sharp domain walls were discovered in ultra-thin iron films on W(110) substrates [11]. In a recent SP-STM experiment we could prove that single monolayers of Fe on W(001) substrates exhibits a c(2x2) antiferromagnetic ground state with perpendicular anisotropy in contrast to a single Fe monolayer on W(110) which is ferromagnetic with in-plane anisotropy [12]. Spin-dependent scattering at single oxygen impurities on Fe/W(110) was visualized in real-space reflecting the orbital nature of the electronic states involved as well as their spin character [13]. Finally, applications of SP-STM for studying spin states of single magnetic impurities will be discussed.

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