Scanning Probe Microscopy Focus Topic
Room: Hall 3 - Session SP-ThP

Scanning Probe Microscopy Poster Session

SP-ThP1 Extreme Magnetic Properties of Co Atoms on MgO Films, ***Christopher Lutz***, *S. Baumann, A. Heinrich, W. Paul, T. Choi*, IBM Research - Almaden

The magnetic moment of a free atom arises from the spin and orbital angular momentum. In a solid state environment, anisotropy in the orbital moment due to the ligand field, together with spin-orbit coupling, gives directionality and stability to the magnetization. Here we use a low-temperature scanning tunneling microscope (STM) to show that Co atoms bound to O sites on a MgO layer achieve a record-high zero-field splitting of 58 meV, which closely approaches the theoretical limit given by the spin-orbit coupling in a 3d transition metal atom. The zero-field splitting gives the energy of the first quantum step required to surmount the anisotropy barrier and reverse the magnetization. The combination of large moment and large anisotropy energy results in magnetic-state lifetimes exceeding 0.2 ms. The high symmetry of the Co atom's binding site gives a ligand field that is effectively cylindrical, which yields a large axial anisotropy while preserving nearly all of the free-atom's orbital angular momentum. All-electrical pump-probe measurements reveal the large magentic moment (5.5 μB) directly in STM. These results provide a symmetry-based strategy for the design of stable nanomagnets.

SP-ThP2 High Resolution qPlus NC-AFM with a New Cryogen-Free Variable Temperature UHV SPM, *C. Troeppner, M. Atabak, S. Molitor, J. Koeble,* ***Bjoern Piglosiewicz****, J. Chrost*, Oxford Instruments

We present first qPlus[1] NC-AFM results of a new cryogen-free cooled ultra-high vacuum compatible scanning probe microscope capable of high stability STM and qPlus NC-AFM operation at temperatures ranging from low temperature up to above room temperature.

The microscope features a cold-sample and cold-tip design. Overcoming the limits of hold time of cryogenic liquids by the cryogen-free approach this microscope provides access to new classes of experiments. Combining drift values much smaller than 1A/h and stable tip conditions enable e.g. unsurpassed long-term spectroscopic SPM measurements.

Decoupling the strong mechanical vibrations induced by the pump of the closed cycle cooler represents a major technical challenge. Our design of the cryogen-free microscope effectively decouples the inherent mechanical vibrations to a level of state-of-the art low temperature SPM’s utilizing cryogenic liquids.

References

[1]] patented, cf. Franz J. Giessibl, APL, Vol. 73, No. 26 (1998)

SP-ThP3 Surface Reconstruction for Accuracy Improvement in Nanoparticle Size Characterization, ***James Su****, N.N. Chu, C.T. Lin, P.L. Chen, M.H. Shiao, C.N. Hsiao, F.Z. Chen*, Instrument Technology Research Center, National Applied Research Laboratories, Taiwan, Republic of China

In this study compares the analytical results of atomic force microscopy (AFM) and scanning electron microscopy (SEM) for characterizing size distributions of various nanoparticles in the size range of (10 – 300) nm. Polymer nanospheres, mixture of colloidal gold and GaN quantum dots were characterized by both techniques. Both techniques were recalibrated with transfer standards traceable to the international metrology institute PTB where the combined uncertainty of measurement results were less than 1%. Average SEM values for mono-size dispersed particles of polymer and gold were slightly lower than the nominal values where AFM values were slightly higher on the contrary. Additional AFM deconvolution process has efficiently reduced the slight broadening of measurement results due to tip effects. Supported by comparisons to published data obtained on quantum dots of increasing diameters, the results show that the apparent size of small details appears to be larger than their actual dimension and the apparent distance between small objects may appear less than their actual dimension. The same method allows us to develop strategies to minimize the errors when the dimension of details is of less the order than the effective resolution of the operated SEM. Most of the size distributions were easily identified with AFM, and the modified average particle size for mono-size dispersed particles is in a good agreement with the nominal values. AFM characterization of nanoparticles using effective deconvolution process and statistical analysis software provides both accurate and rapid analysis for nanoparticle characterization.

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