NANO HIGHLIGHT
Spin-Polarized Scanning Tunneling Microscopy: a Tool for the Study of Nanomagnetism

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As electronic devices continue to become smaller and faster, it is increasingly important to explore the properties of the basic building blocks of these devices (i.e. transistors and magnetic bits) as their size approaches the nanoscale. In particular, the field of *nano*magnetism is attracting many researchers due to the importance of this field to the future technology. Yet a question arises: how can one measure magnetic properties at such small (nanoscale) sizes?

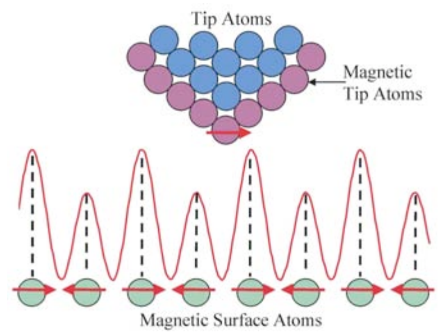

Fig. 1. Schematic illustration of the SP-STM method. The tunneling current and thus the height depends on the relative orientations between tip and sample spins.

The answer is a powerful technique known as "spin-polarized" scanning tunneling microscopy (SP-STM).[1] The "spin" of an electron is one of its fundamental quantum mechanical properties. When a large group of spins "line up", a small magnetic "bit" is formed. We are interested in studying magnetic bits whose size approaches that of single atoms. The method of SP-STM works by approaching a sharp, needle-like magnetic probe tip to the sample surface to within a distance of just 1 or 2 atomic diameters. When a small voltage is applied between tip and sample, a tiny "tunnel" current flows. The tunnel current depends on the relative orientation of tip and sample spins. The signal looks like a series of peaks whose height is modulated, as in Fig. 1.

Interesting results on Mn_3N_2 (010) are obtained as a function of voltage.[2] Shown in Fig. 2 are the images obtained at 2 opposite voltages. Adjacent rows have opposite spin directions, indicated by the modulation of the height of the line profiles. However, the polarity of the STM contrast depends on the voltage. This result is important for measurement of nanoscale magnetic structures.

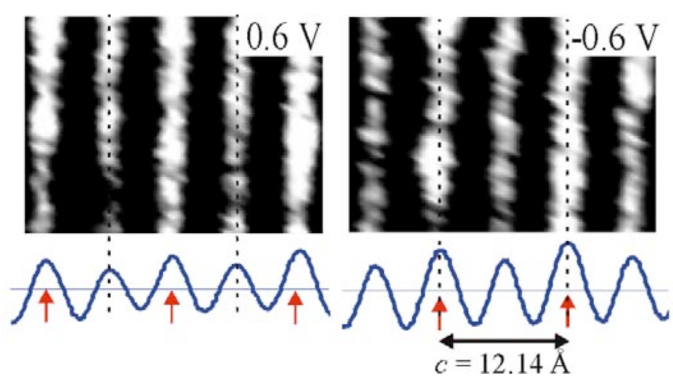

Fig. 2. Atomic-scale SP-STM images of Mn_3N_2 (010) obtained at opposite voltage polarity between tip and sample. The two images show the opposite magnetic contrast.

References

[1] For further information about this project link to http://nsnm.phy.ohiou.edu or email smitha2@ohio.edu or hla@helios.phy.ohiou.edu or ulloa@helios.phy.ohiou.edu or sandler@helios.phy.ohiou.edu.

[2] Arthur R. Smith, Rong Yang, and Haiqiang Yang, Bias-Voltage Dependence in Atomic-Scale Spin Polarized Scanning Tunneling Microscopy of Mn_3N_2 (010), Mat. Res. Soc. Symp. Proc. **803**, GG1.2 (2004).