Magnetic and Electronic Properties of Ordered Iron Oxide Nanocrystal Arrays

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This work is aimed at studying both the single nanocrystal and the collective array properties of organically passivated magnetite (Fe_3O_4) and maghemite (Fe_2O_3) nanocrystals. Two-dimensional arrays of the nanoparticles coated with oleic acid were prepared at the air-water interface using the Langmuir Blodgett technique [1].

I-V spectra of tunneling junctions consisting of a stack of several particle monolayers show interesting temperature dependence [2]. Surprisingly, the magnetite nanocrystals undergo the first-order Verwey Metal-to-insulator transition around 100K, in spite of the large surface to volume ratio. The tunneling spectra show large magnetic field sensitivity giving rise to very large magnetoresistance values at low bias voltages. Low temperature STM measurements (at the group of Oded Millo, Hebrew University) of isolated particles provide similar tunneling spectra.

The magnetic properties of the 2D arrays show significant differences compared to isolated nanocrystals as well as differences from quasi-3D arrays made by stacking several monolayers. AC susceptibility measurements show that the 2D case has unique magnetic behavior due to anisotropic dipolar inter-particle interactions and indicate that collective freezing of magnetization occurs at the close-packed arrays.

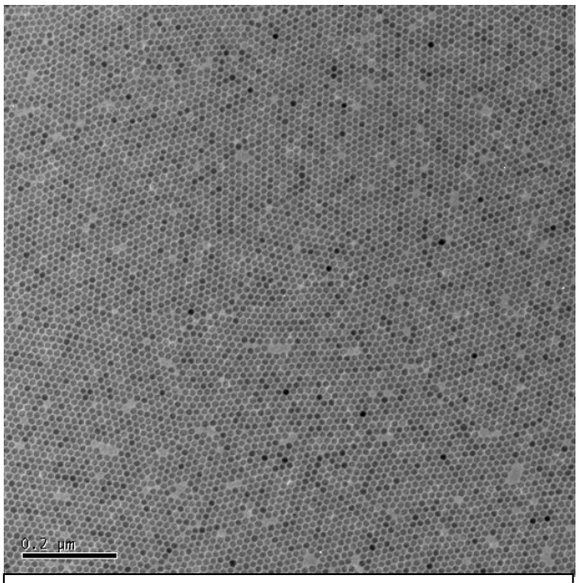

Figure: Two-dimensional array of 13 nm diameter iron oxide particles produced by the Langmuir-Blodgett technique. The particles were synthesized by Hyeon et al., Seoul National University[3].

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[1] ˜T. Fried, G. Shemer, G. Markovich, *Adv. Mater.* **13**, 1158 (2001).

[2] P. Poddar, T. Fried, G. Markovich, *Phys. Rev. B* **65**, 172405 (2002).

[3] T. Hyeon, S. S. Lee, J. Park, Y. chung, H. Bin Na, *J. Amer. Chem. Soc.* **123**, 12798 (2001).