SIZE- AND SHAPE-CONTROLLED NANOMAGNETISM OF NiO

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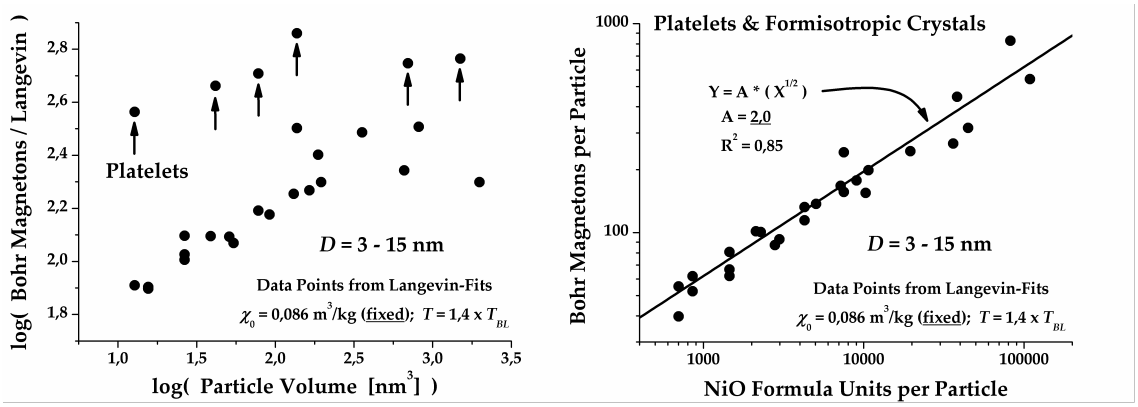
During the last 50 years, nickel oxide NiO in the nanocrystalline (nc) state has become an archetypal antiferromagnet with unusual magnetic properties due to finite-size [1]. A spontaneous net magnetization of the nanocrystals, not observed in the fully compensated bulk phase, gives rise to phenomena like superparamagnetic blocking and hysteresis [2]. The origin of the surplus spins is still a matter of speculation. It is well known that conventionally prepared nc-NiO, as employed in previous magnetization studies, is distinguished by a marked shape anisotropy [3]. This complicates the interpretation of the magnetic behaviour. In contrast, we have devised a novel synthetic route to formisotropic nc-NiO, starting from suitable metal-organic precursors. We are able to adjust the crystallite size via programmed thermal annealing. In addition, we have prepared NiO nano-platelets of a large aspect ratio by a conventional route, again controlling the crystallite size by programmed annealing. Thus we are in a position to investigate the magnetic properties of nc-NiO as a function of both the size and the shape of the nanocrystals.



The graph on the left shows magnetic moments, obtained from Langevin fits to the field dependent magnetisation of nc-NiO, for sizes from 3 to 15 nm. For the nano-platelets (arrows) the magnetic moment is significantly enhanced due to shape anisotropy. Nevertheless, the renormalized plot on the right demonstrates for the first time that all the samples fit Néel's statistical model [1], according to which the number of spins per particle is equal to the square root of the overall number of Ni atoms. From the linear fit, the magnetic moment per atom is 2,0 Bohr magnetons, in good accord with theory.

[1] L. Néel, in *Low Temperature Physics*, C. De Witt et al., eds., Gordon and Breach, New York, **1962**, pp. 412-440; J. T. Richardson et al, *Journal of Applied Physics*, **1991**, *70*, 6977-6982.
[2] J. T. Richardson, W. O. Milligan, *Physical Review*, **1956**, *102*, 1289-1294; S. A. Makhlouf et al., *Journal of Applied Physics*, **1997**, *81*, 5561-5563.
[3] S. N. Klausen et al., *Physica Status Solidi (a)*, **2002**, *189*, 1039-1042; M. S. Seehra et al., *Journal of Applied Physics*, **2005**, *97*, 10J509.