QE06

The Fractal Magnetic Structure in the Co-based Nanocomposite Atpercolation Threshold

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Currently nanocomposites with typical size of elements smaller than several nanometers are in focus. Composite granular systems exemplify such nanocomposites and can be interesting not only for fundamental investigations but also for industrial applications.

We investigated the composite nanostructures $(Co)_x(SiO2)_{1-x}$ and $(Co)_x(CaF)_{1-x}$, which were obtained by the method of ion-beam sputtering in the atmosphere of argon. For Co concentrations (x) in the range of 0.37-0.80, samples consist of metal granules (2-7 nm) randomly distributed in a dielectric matrix. The size of granules monotonically increases as concentration of magnetic material rises [1]. The small-angle neutron scattering investigations of $(Co)_x(SiO2)_{1-x}$ and $(Co)_x(CaF)_{1-x}$ nanocompositeswere carried out with the time-of-flight small-angle-scattering spectrometer YuMO [2] at the IBR-2 reactor in Dubna (Russia). The Q-range was chosen from $0.006Å^{-1}$ to $0.3Å^{-1}$.

It was found that the magnetic structure of nanocomposites changed at threshold concentrations of about x=0.4-0.5, where transition from the superparamagnetic phase to the ferromagnetic phase occurred. Neutron scattering from nanocomposites shows that the magnetic structure is the fractal one near the percolation threshold. For such concentrations the scattering intensity of the small-angle neutron scattering is well described by $I(Q)\sim Q^{-a}$, where a = 2-4 and Q is a momentum transfer function.

Our studies show that the structural size of granules is smaller than their magnetic size above the percolation threshold. This is most likely due to ferromagnetic exchange in composites. Formation of magnetic clusters in the nanocomposite granular system at the percolation threshold bring changes in magnetic structure and the behavior of the neutron scattering.

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QE07

Tuning Fork based Magnetic Force Microscope

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The quartz crystal tuning forkhas been used as a force sensor for near-field scanning optical microscopy, atomic force microscopy, and magntic force microscopy.[1-3] We have developed a low-temperature magnetic force microscope using a quartz tuning fork operating at 4.2 K in high magnetic field (5 T). A silicon tip from a commercial cantilever was attached to one prong of the tuning fork. With a metallic coating, a potential could be applied to the tip to sense the charge distribution in a sample, while with a magnetically coated tip, magnetic force imaging could be performed. For the coarse approach mechanism, we developed a reliable low-temperature walker with low material cost and simple machining. We have obtained Coulomb force images of boron nanowires at room temperature and magnetic nano-structures at low temperature. For lift-mode scanning, we employed a frequency detection mode for the first topographic scan and phase detection mode for the second lift scan. As a result, the tuning fork is apromissing sensor for low temperature high-vacuum,scanning probe microscopy, because it has very low heat dissipation (~pW) and no light source is required in operation.

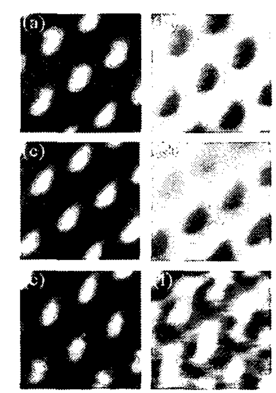

Fig. 1. Topography and MFM images at 4.2 K. MFM measurements were performed on a $SrRuO_3$ nanodot array at 4.2 K in a magnetic field. Topographic (a, c, e) and MFM images (b, d, f) were obtained simultaneously at 0, 1.5, and 3 T magnetic fields, respectively. The area of the scans is 1x 1 μm^2.

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