Transition to superparamagnetism in nanostructured alloys: the importance of dipolar interactions between nanoparticles

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Soft magnetic nanocrystalline alloys have been a field of intensive research during the last decades due to their potential applications. Generally, their microstructure consists of ferromagnetic crystals with grain sizes in the nanometer range, embedded in a ferromagnetic amorphous matrix. Nowadays, there is an effort to extend the outstanding soft magnetic properties of these materials to higher temperatures and, for this purpose, it is important to understand the decoupling of the nanocrystals, which is one of the processes that limit the working temperature.

During this talk we will focus our attention on Finemet and Nanoperm type nanocrystalline alloys. It will be shown that, in the temperature region above the coercivity maximum, the experimental hysteresis loops can be accurately fitted by a combination of two models which use effective field controlled memory effects and temperature rescaling to describe dipolarly interacting superparamagnetic particles. The characteristic parameters of these two models (interaction temperature and interaction field) are interrelated. By using this approach, physically meaningful values for the temperature dependence of the magnetic moment of the nanoparticles are obtained. The influence of the particle size distribution on the applicability of the mean-field model will also be considered.