Stepwise behaviour of magnetization temperature dependence in iron nanoparticle assembled films.

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An unusual stepwise behaviour was observed in the temperature dependence of zero field cooled (ZFC) magnetization in iron nanoparticle (NP) dense films, produced by ultrashort pulsed laser deposition. This result is striking because nanostructured magnetic materials produced by other techniques typically show a ZFC magnetization increasing monotonously with the temperature. We have interpreted this behaviour by means of phenomenological modeling and Monte Carlo simulations addressing the peculiar morphology of the nanostructure. Key elements are: 1) competition between Zeeman, intracluster anisotropy and intercluster exchange energy densities; 2) slow change of the anisotropy and exchange energy density with temperature; 3) quasi two-dimensionality of the system. This finding allows conceiving nanostructured materials very sensitive to the local magnetic field gradient, with potential applications in, e.g, sensor devices, nanoscope tips and magnetic read heads.

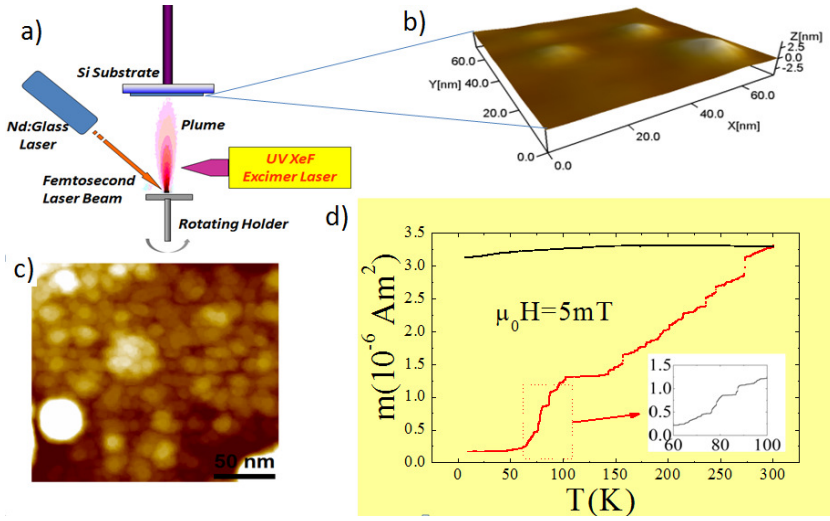

Fig. a): Sketch of the experimental setup: the NPs median size and size dispersion is controlled by irradiating the NPs in-flight with ns UV pulses. Fig. b): Typical AFM image of isolated Fe NPs. Fig. c): HRSEM image of Fe NPs assembly. Fig. d): Stepwise behaviour of the ZFC magnetization curve.