Research on magnetic nanostructures at NIMP

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- Some topics
- Nanostructures possible to be provided
- Expertise and available characterization methodologies

Some topics:

- Preparation and characterization of complex nanostructures responding to magnetic stimuli

- Understanding fundamental aspects regarding their magnetic behavior in order to improve performances with respect to given applications

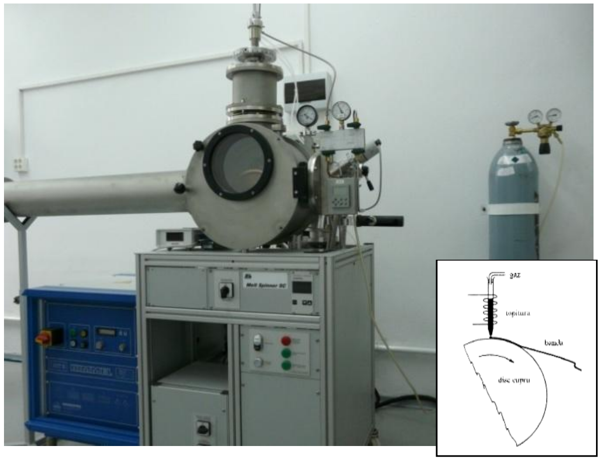
- *Intermetallic nanostructures for permanent magnets (hard-magnets: exchange spring nanocomposites and multilayers)*

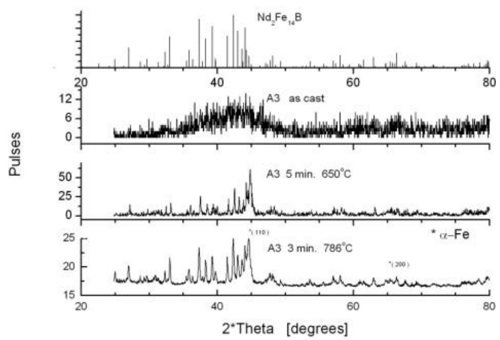
- *Intermetallic nanostructures for fast magnetic response (soft magnets: amophous ribbons, layered structures).*

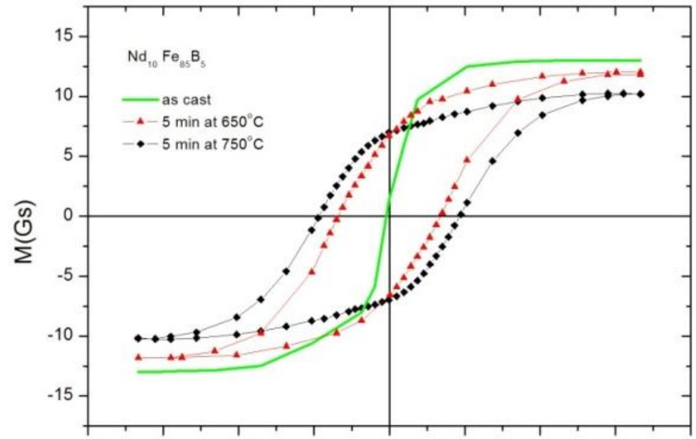
- *Magneto-functional nanostructures (magneto-conductive spin-valves as multilayers and nanogranular structures, magneto-elastic and ferromagnetic shape memory alloys.*

- *Nanoparticles dispersed in various media (m*agnetic nanoentities dispersed in metallic/semiconducting/polimeric matrices, functionalized nanoparticles)

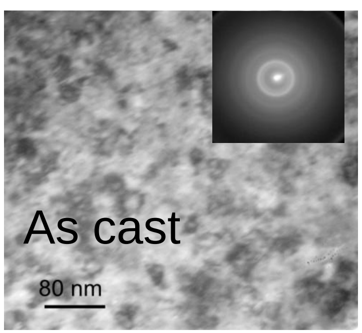
Exchange spring nanocomposites from amorphous ribbons

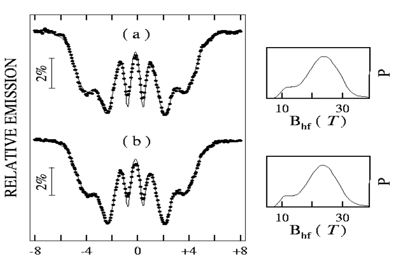


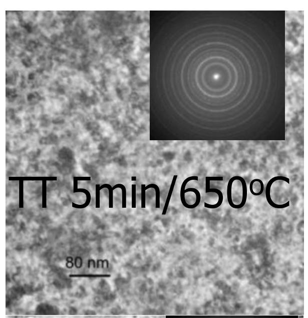


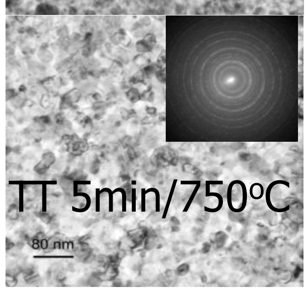


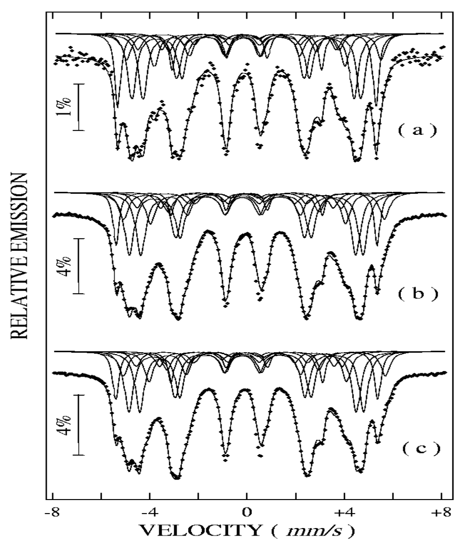
$Nd_2Fe_{14}B$+15%Fe

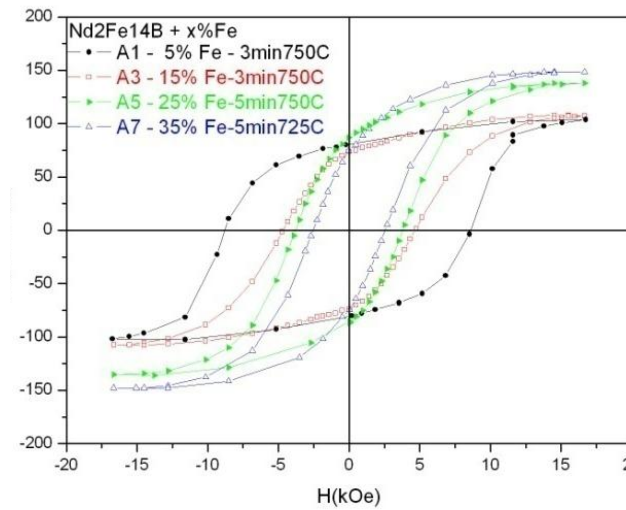




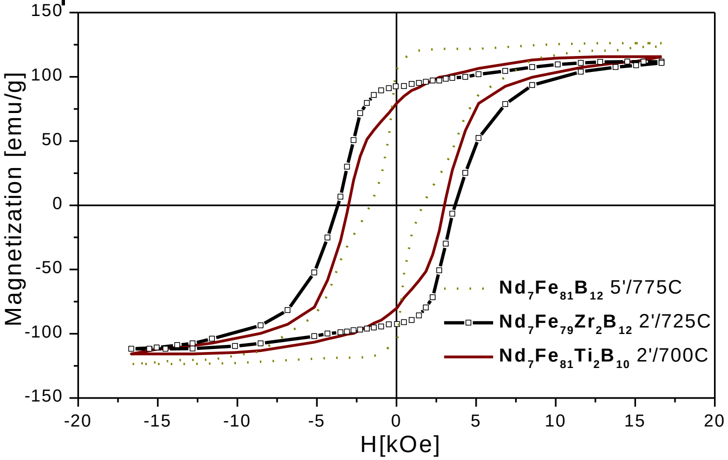


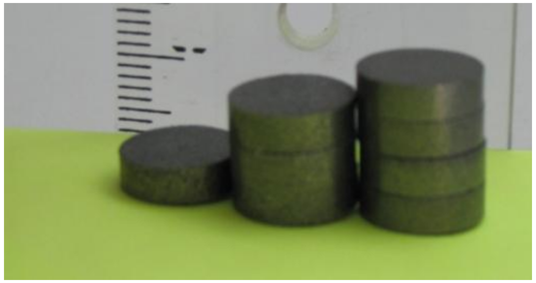




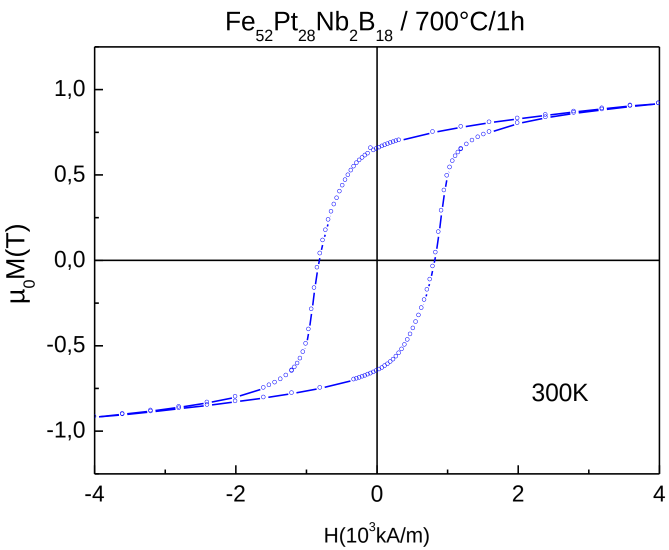


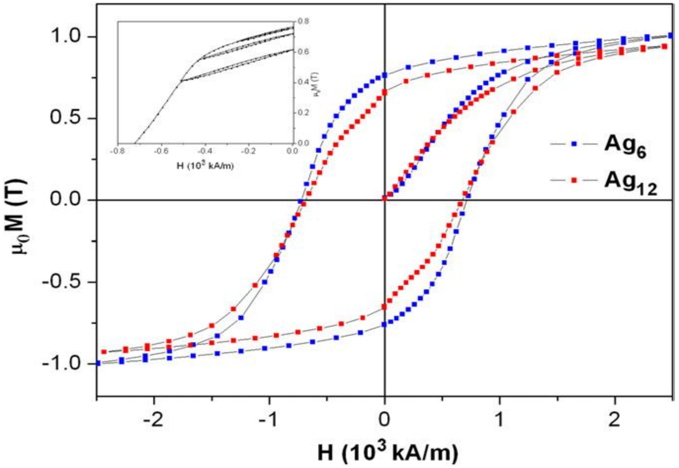
Nd-Fe(Ti/Zr)-B: increases the energy product from 150 kJ/m3 to 250 kJ/m3





$Fe_{52}Pt_{28}Nb_2B_{18}$ -700C/1h - $(BH)_{max}$=69 kJ/m^3

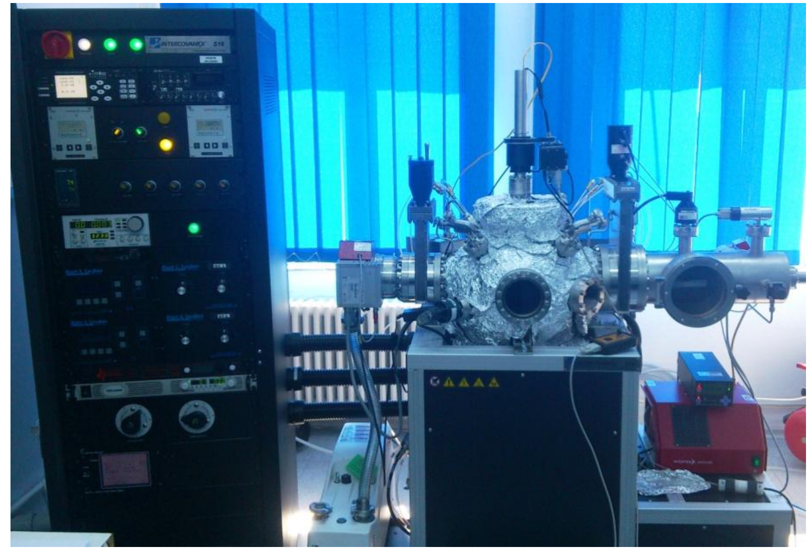




$Fe_{48}Pt_{28}Ag_6B_{18}$ as cast - $(BH)_{max}$=87 kJ/m^3

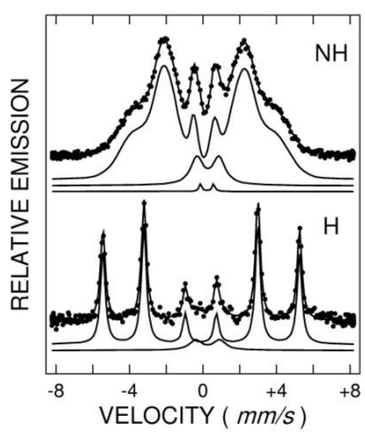
$Fe_{42}Pt_{28}Ag_{12}B_{18}$ as cast - $(BH)_{max}$=58 kJ/m^3

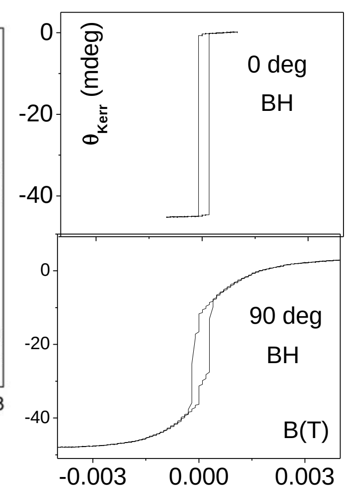
Soft magnetic materials (ribbons and thin films)

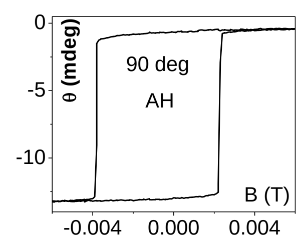


Intermetallics of type:
Fe-B, Fe-Si-B, Fe-Ni-B,
Fe-Co, Finemet (Fe-Cu-Nb-Si-B), as ribbons.

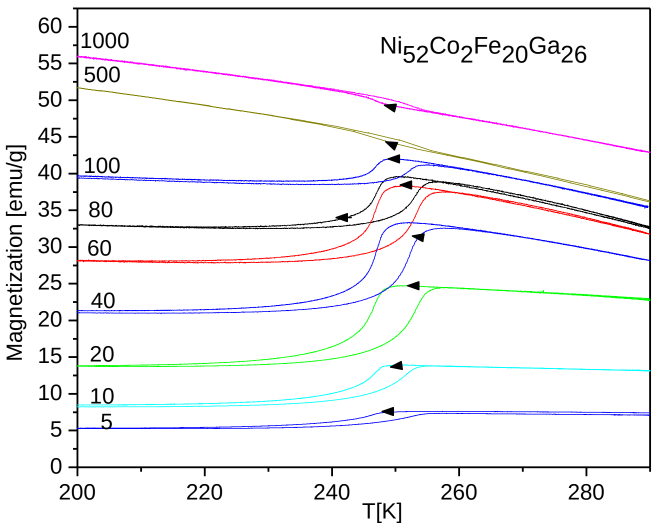
Fe-Si, Fe-Ni(Si), Fe-Co(Si), as thin films with tunablemagnetic properties

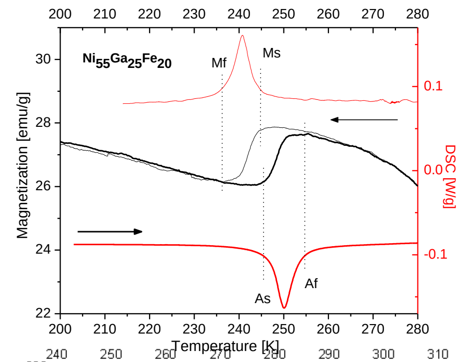


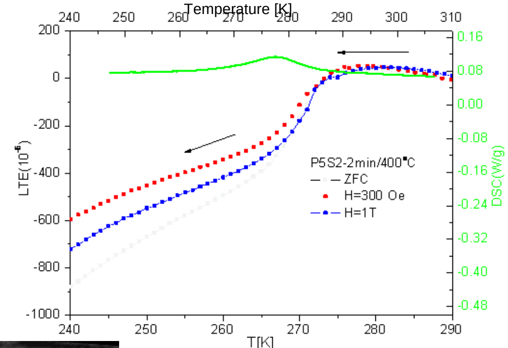


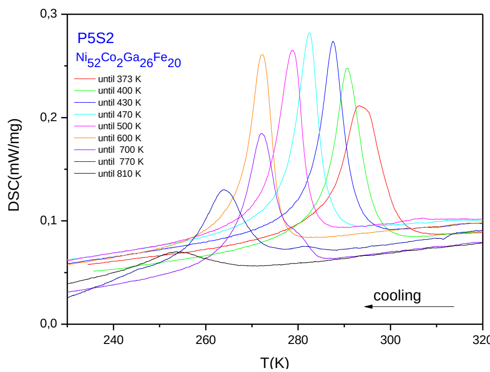


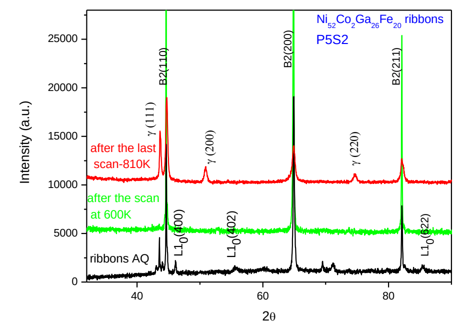
Ferromagnetic and non-ferromagnetic shape memory alloys

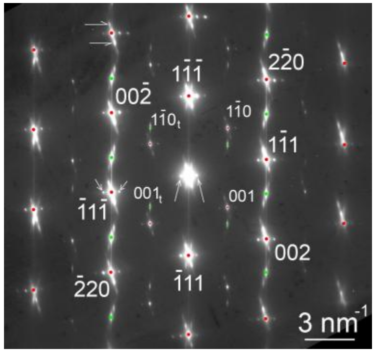


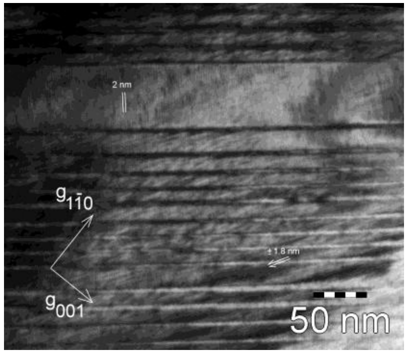












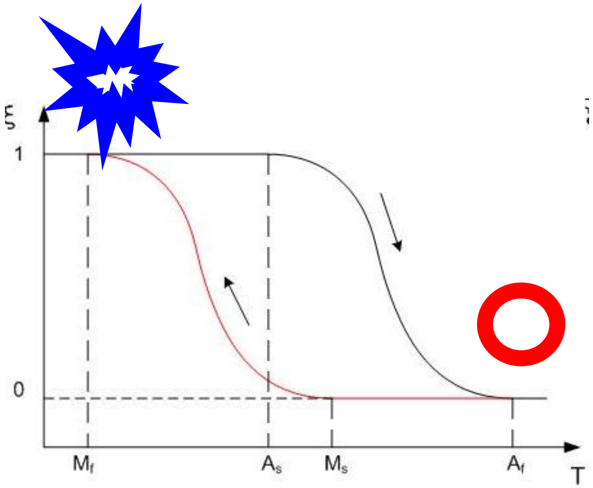
Ferromagnetic (Ni-Fe-Ga and Fe-Pd) and non-ferromagnetic (Ti-Ni-Cu) shape memory alloys obtained by nonequilibrium methods are currently under investigation

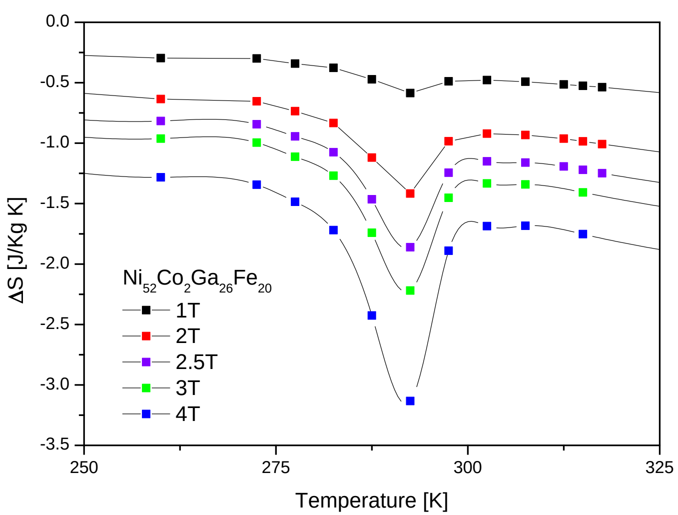
SAED pattern of a specimen region oriented along **B** = [110]; tetragonal system: a=b=3.78 A, c=3.29 A, c/a=0.87; twinning plane (-111); red spots correspond to the matrix lattice; green spots correspond to the twin stripes. TEM image of the twined region

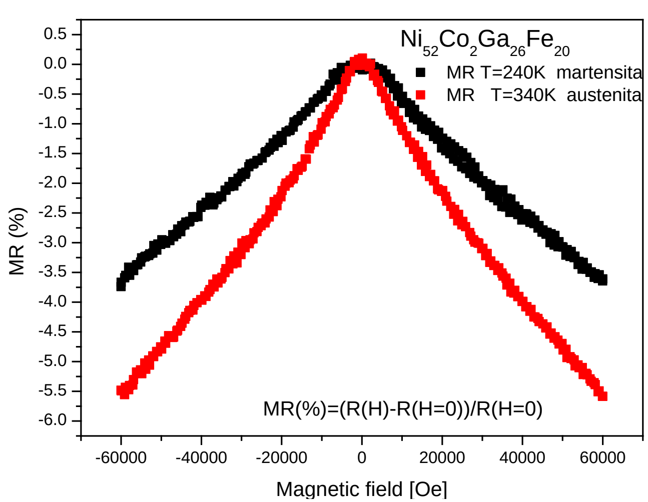
Ferromagn. Shape Memory alloys: **multifunctional materials**. The magnetic-field-induced strain (giant magnetostiction) can be used for high-performance magnetomechanical actuation.

Their rapid and contactless response, suggests that FSMAs are suitable for micro or nanoscale devices.

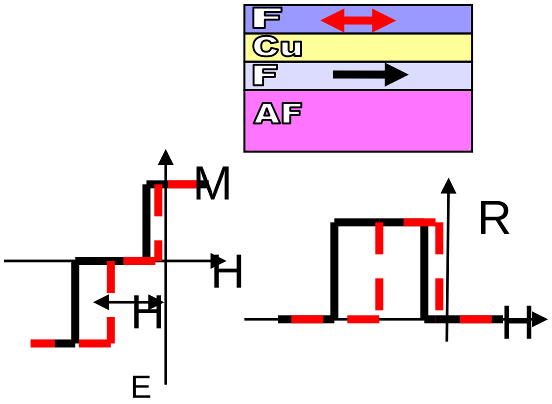
The large changes of electrical resistivity or magnetization in materials with stable magneto-structural coupling are useful for switching devices or magnetocaloric applications.

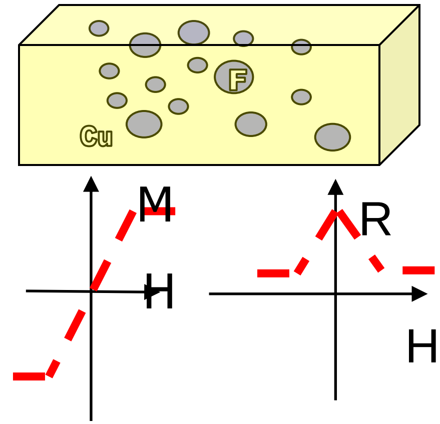




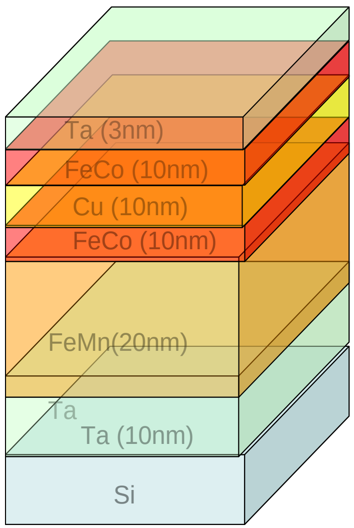


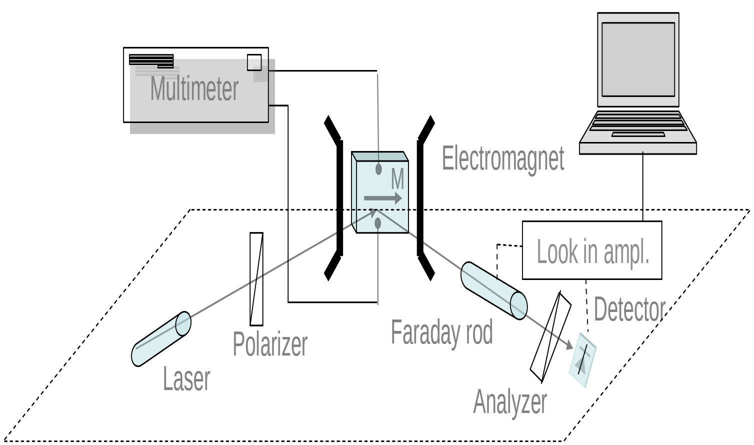
Magnetoresitive elements (spin valves), as multilayer and nanoglobular

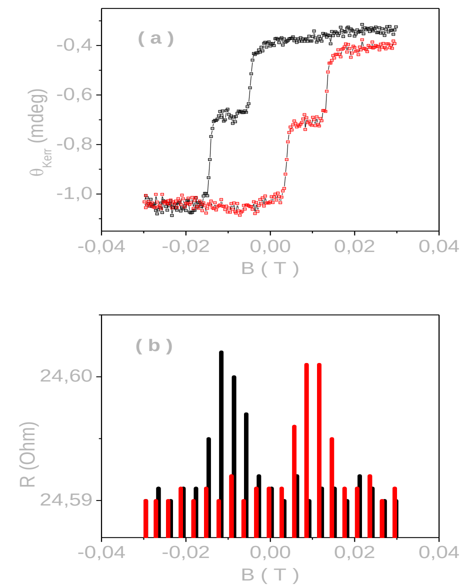




Fe, Fe-Ni, Fe-Co clusters in Cu and Ag matrices







Expertise and available characterization methodologies

Characterization by:

•Magnetomentry (MPMS-SQUID, PPMS and VSM)

•Magneto-optic Kerr Effect and contrast interferometry

•Mossbauer spectroscopy (all techniques from CEMS to temperature/field dependent γMS

•Thermal properties (DSC, Flash calorimetry, PPMS)

•Magneto-transport and magneto-striction

•Gas absorptin/desorption kinetics

• AC magnetic susceptibility in RF range

Suitable methodologies for:

• characterization of the field and temperature dependent magnetic response

•Characterization of magnetic texture and easy axis distribution in particulate media via Magneto-optic Kerr Effect and Mossbauer spectroscopy

•Precise evaluation of Fe phase composition and direct relation between the magnetic parameters and structural and morphological aspects. Metalurgical phase composition and corrosion phenomena. Characterization of structural and magnetic phase transitions.

•Magneto-transport and magneto-striction with respect to magnetic behavior

•Gas absorptin/desorption kinetics for studying gas storage and influence on magnetic properties

•Magnetic relaxation of functionalized NPS, heat tranfer phenomena and SAR determinations

Thank you for your attention !