Iron oxide: magnetic hyperthermia and encapsulation

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CONDENSED MATER PHYSICS LABORATORY

Research interest

- nanoparticle magnetism
- dynamic phenomena in magnetic nanoparticle systems
- applications of magnetic nanoparticles in medicine:
  - magnetic hyperthermia
  - radiolabeling of magnetic nanoparticles
  - drug targeting

Facilities

- MPMS 5XL SQUID
- MS4 Mössbauer Spectrometer
- XRD – diffractometer Bruker AXS D8
- FTIR Nicolet iS50 ATR

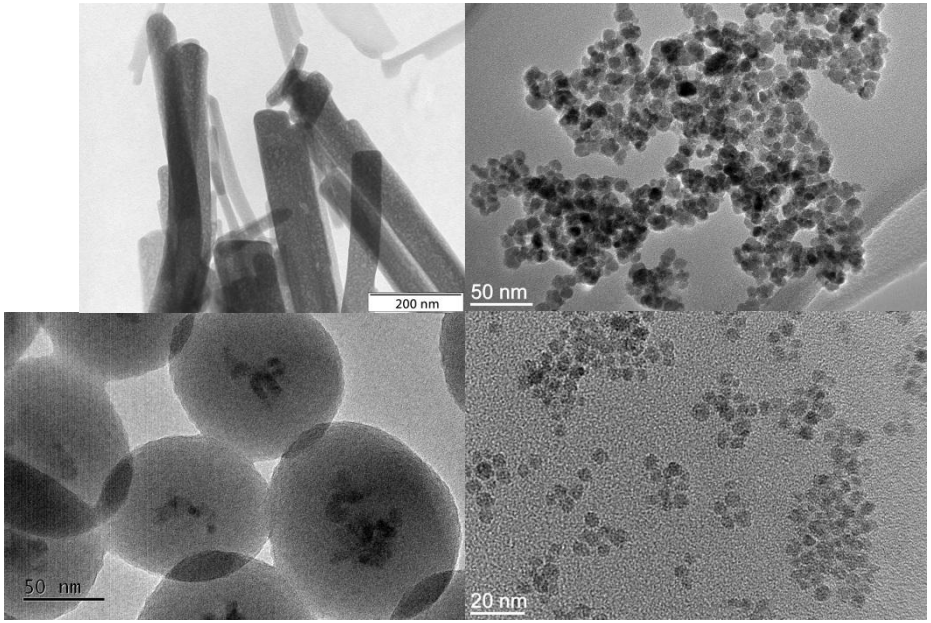
SYNTHESIS ROUTES AND SYSTEMS INVESTIGATED

Routes

- aqueous coprecipitation
- thermal decomposition of organic complexes
- microemulsion
- sol gel
- mechanochemistry
- combustion synthesis

Systems

- Iron oxides, ferrites, manganites



Magnetic nanoparticles: hyperthermia

- hyperthermia = heating of the body or part of the body beyond physiological temperature
- magnetic hyperthermia:
  magnetic nanoparticles + AC field = heating
- mechanism: hysteresis loss
  - domain wall motion :: bulk
  - domain reorientation :: blocked monodomain
  - relaxation :: Neel or Brown

Magnetic nanoparticles: relaxations

Simple model : field independent

- thermal Neel

$$\tau_N = \tau_0 e^{\frac{KV}{kT}}$$

- mechanical Brownian

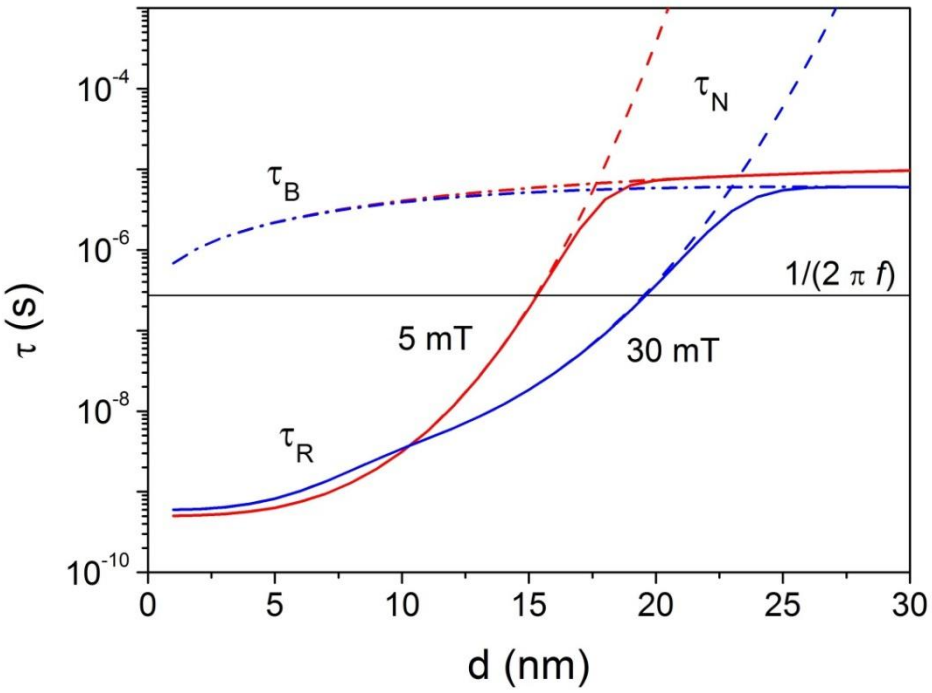
$$\tau_B = \frac{3\eta V_h}{kT}$$

- effective

$$\frac{1}{\tau_R} = \frac{1}{\tau_N} + \frac{1}{\tau_B}$$

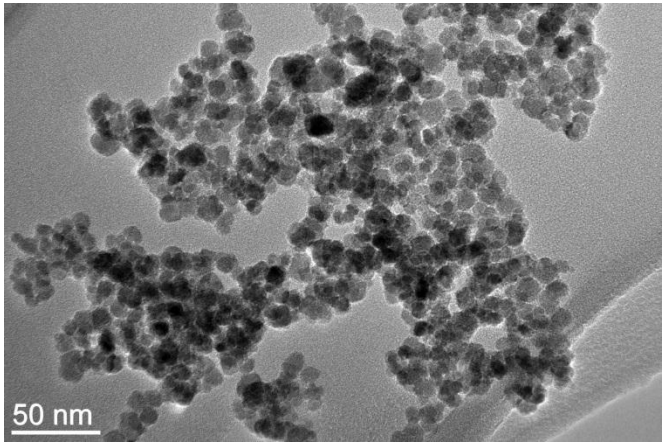
Not so simple: field dependent

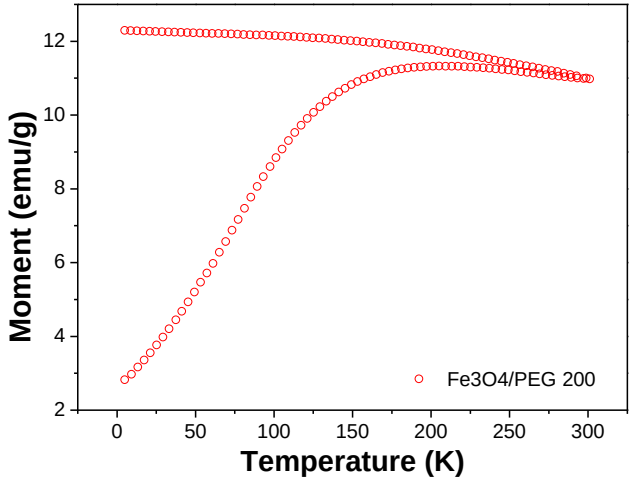
- τ_N and τ_B are functions of field amplitude

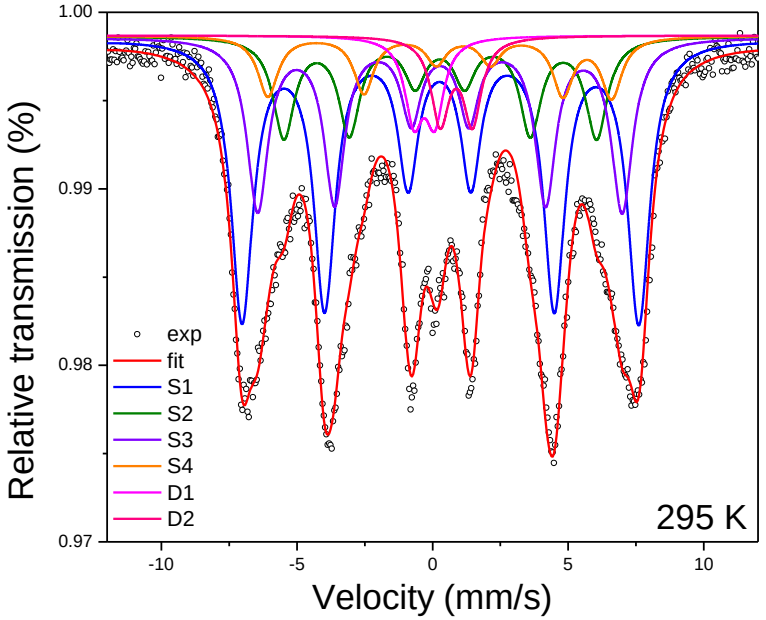


Magnetic hyperthermia: real example

- Iron oxide synthesized by coprecipitation
- Coated with PEG to get stable dispersion
- Characterized by XRD, SQUID, TEM, Mössbauer

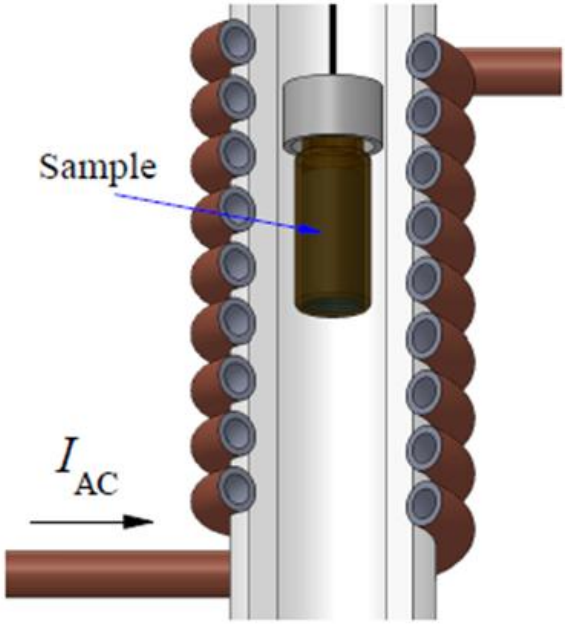




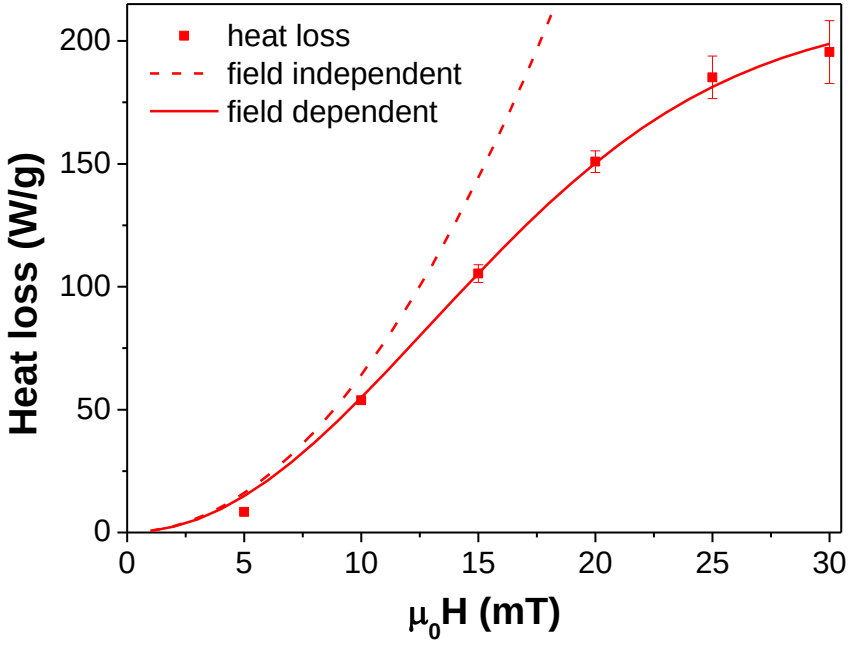


Magnetic hyperthermia: real example

- Calorimetric measurements of heat loss in different AC fields



- Results



  - Field dependent relaxations must be used for fitting

Magnetic nanoparticles: encapsulation

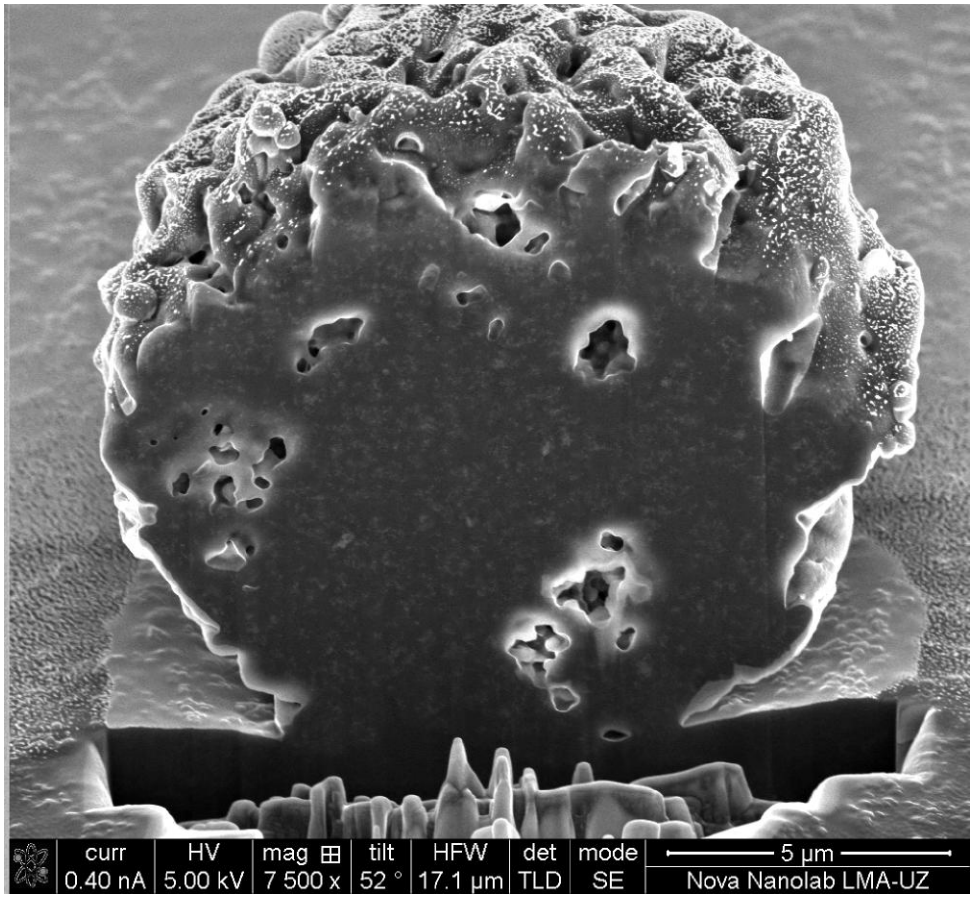
Why?

- multifunctionality

  magnetic hyperthermia
  +
  radionuclide therapy

Result:

- iron oxide nanoparticles in human serum albumin microspheres



Thank you for your attention.