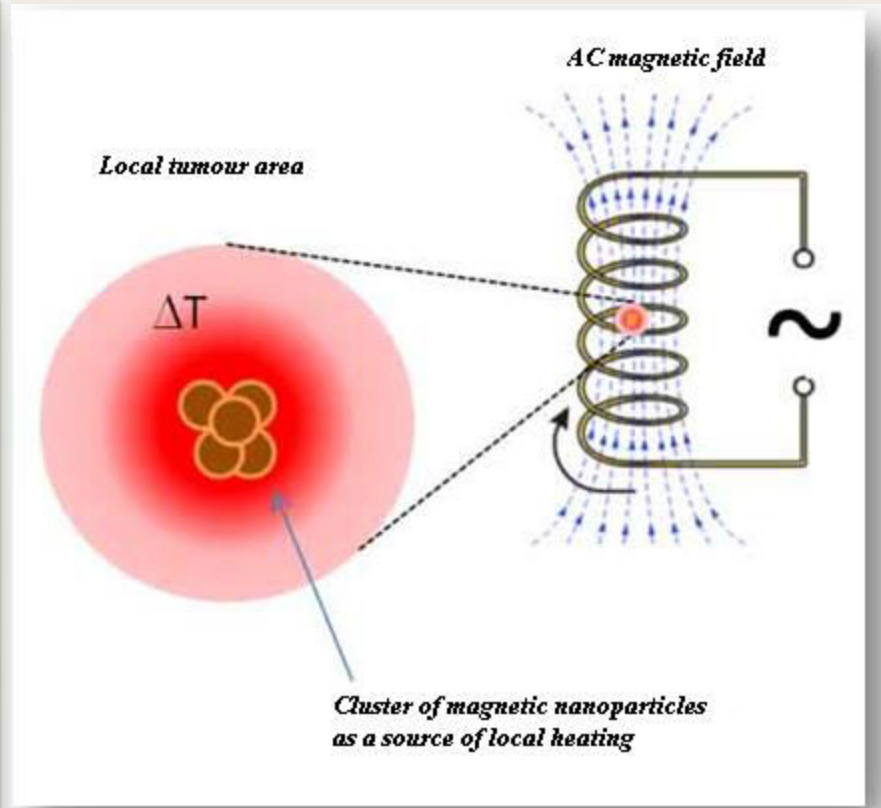
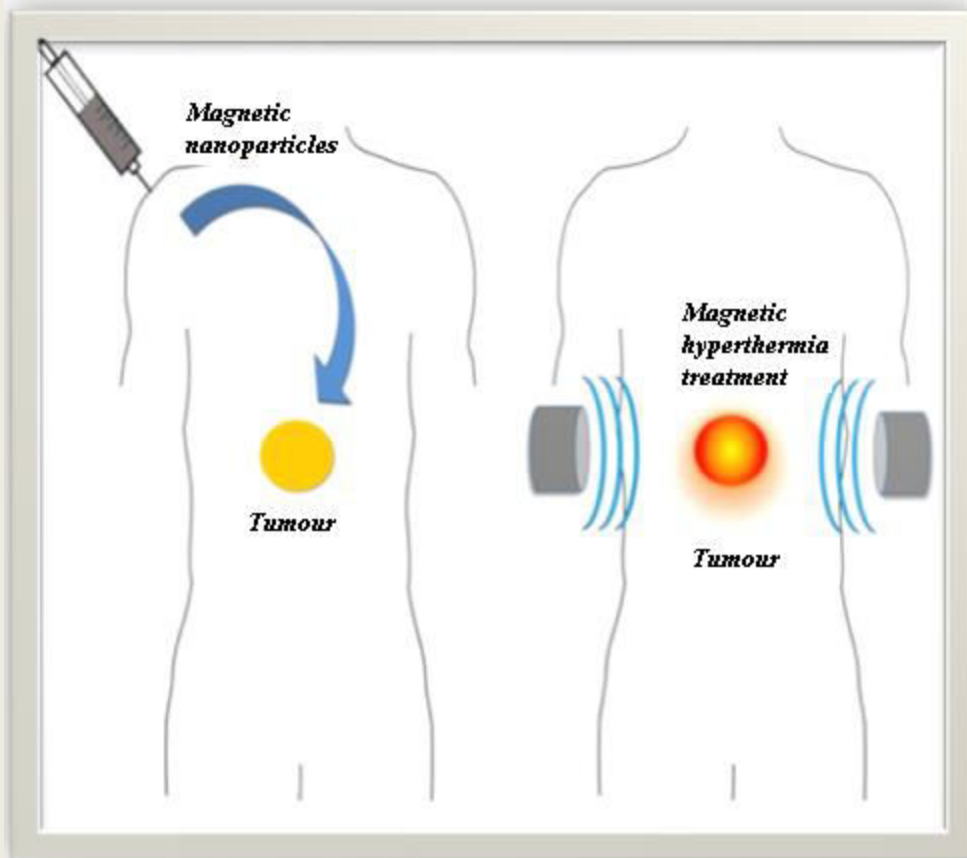


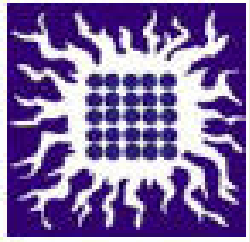
Solvothermal synthesis of magnetite nanoparticles suitable for application in magnetic hyperthermia

V. Nikolić, A. Mraković, M. Perović, M. Bošković, V. Spasojević, V. Kusigerski and J. Blanuša

*Vinča Institute of Nuclear Sciences - University of Belgrade,
Condensed Matter Physics Laboratory*

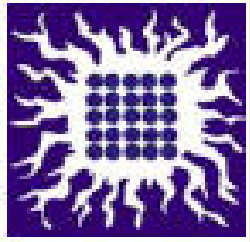
Magnetic hyperthermia





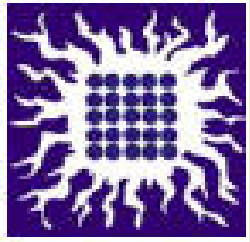
Motivation and Problem Statement

- **Fe₃O₄ is one of the most promising magnetic materials for magnetic hyperthermia**
- ✦ **Motivation for investigation – to enhance the knowledge about synthesis conditions enabling synthesis of the hyperthermia agents**



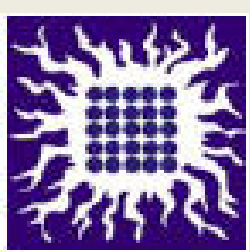
The research aim

- ◆ **tailor size, shape and the degree of the interparticle interactions by varying synthesis route**
- ◆ **coating of the nanoparticles, in order to get hyperthermia agents with SLP value properly for hyperthermia treatment**



Outline of presentation

- **Synthesis of Fe_3O_4 nanoparticles**
- **Structural characterization – XRD**
- **DC Magnetic measurements – SQUID**
- **Mossbauer measurements – Mossbauer spectroscopy**



Solvothermal synthesis of Fe_3O_4

$FeSO_4$

+

$H_2O/EtOH$

+

OA

+

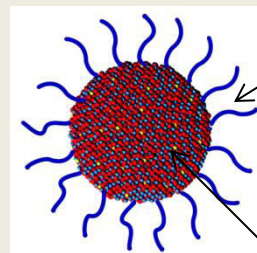
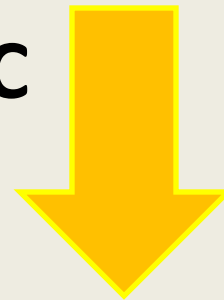
NaOH

$T = 180^\circ C$

$t = 10h$

teflon

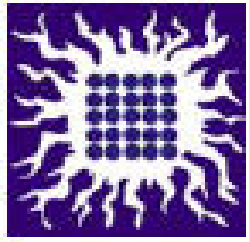
autoclave



OA

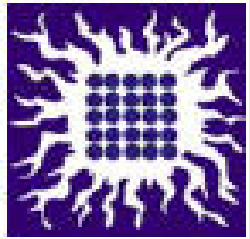
Fe_3O_4



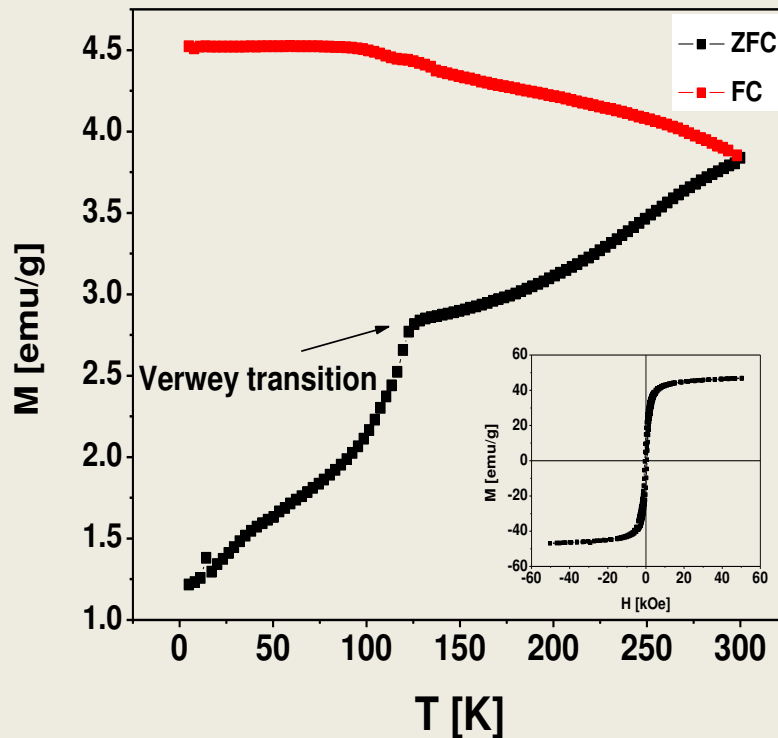
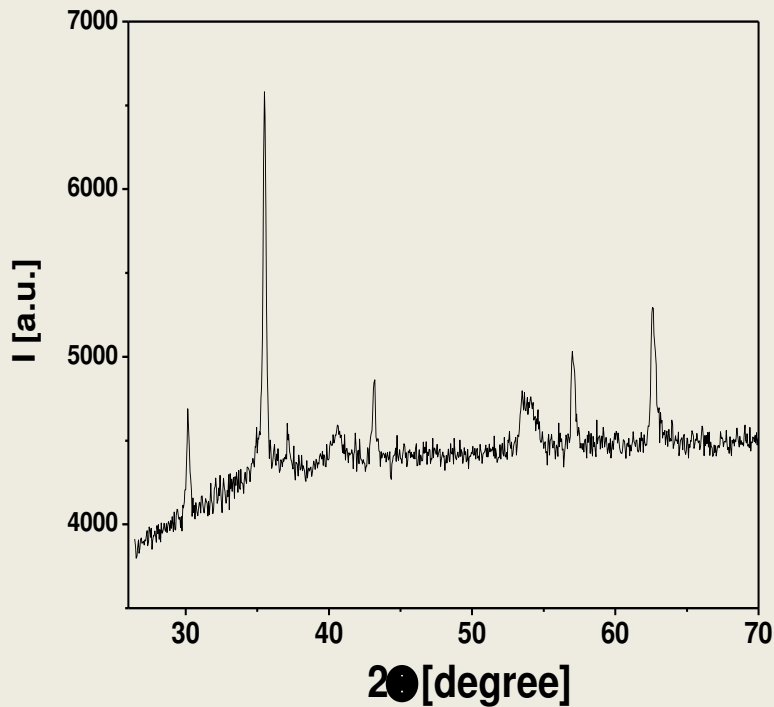


Tailoring synthesis conditions

- *I sample [bulk Fe_3O_4]*
precursors: sodium hydroxide, water, ethanol, oleic acid (**first solution**); iron sulphate heptahydrate, water (**second solution**)
- *II sample [nano Fe_3O_4 “seeded-drop to drop”]*
precursors: sodium hydroxide, water, ethanol, oleic acid (**first solution**); iron sulphate heptahydrate, **sulfuric acid**, water (**second solution**)
- *III sample [nano Fe_3O_4]*
precursors: sodium hydroxide, water, ethanol, oleic acid (**first solution**); iron sulphate heptahydrate, **sulfuric acid**, water (**second solution**)

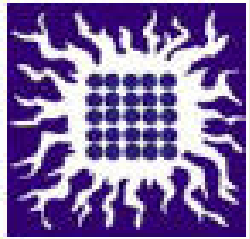


Sample I: structural and magnetic characterization

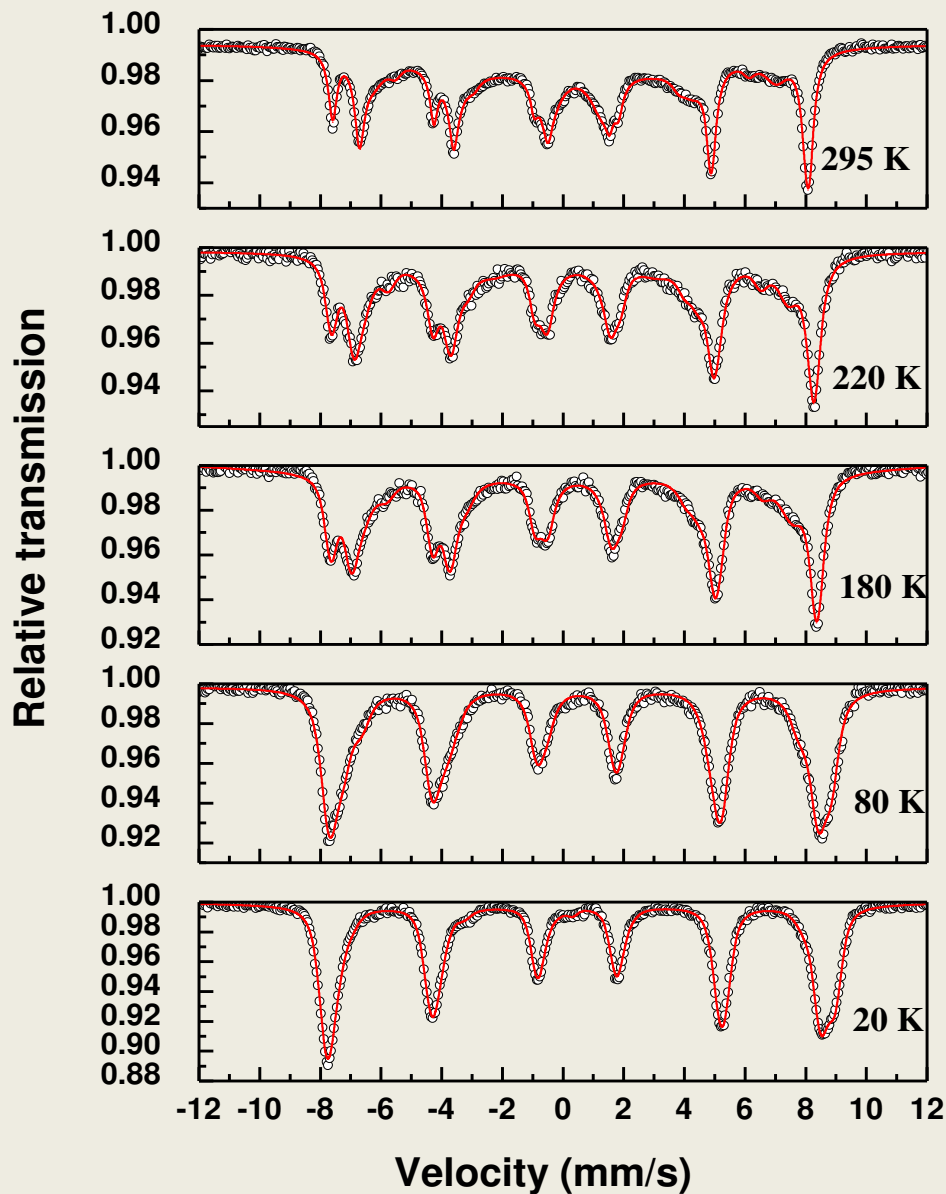


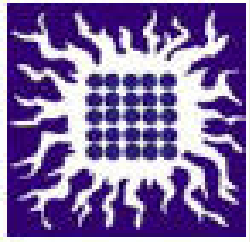
➡ Scherer formula $\rightarrow d_c = 260\text{ nm}$!

☀ ZFC/FC curves of the sample I, inset: hysteresis.

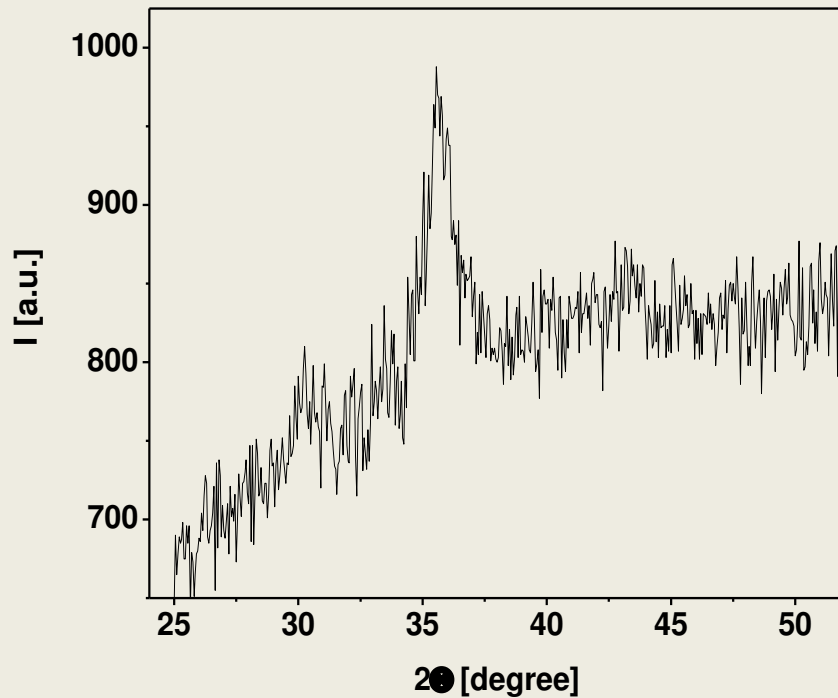


Sample I: Mossbauer spectra

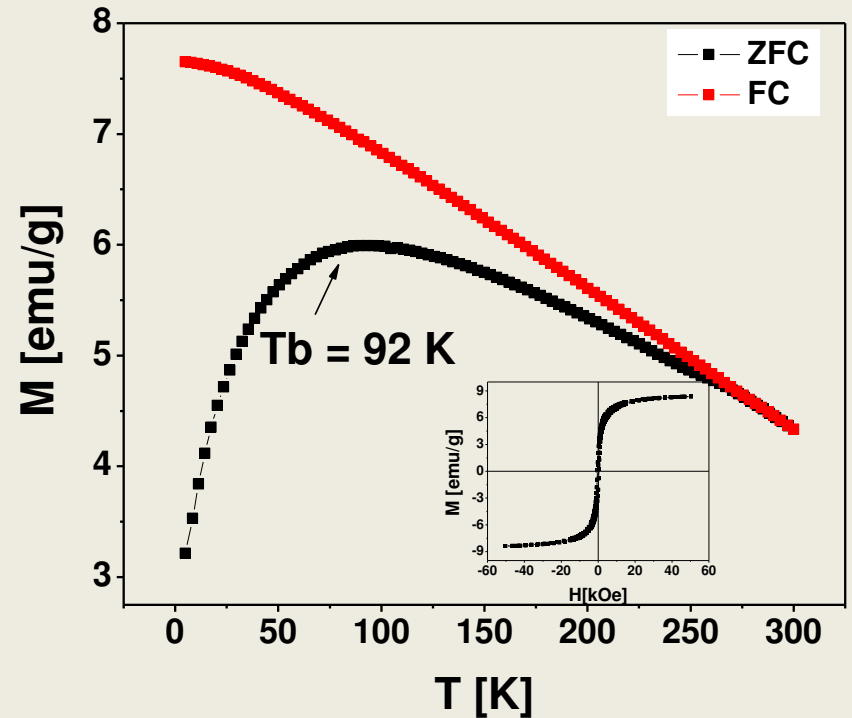




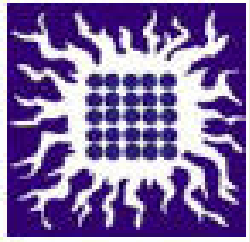
Sample II: structural and magnetic characterization



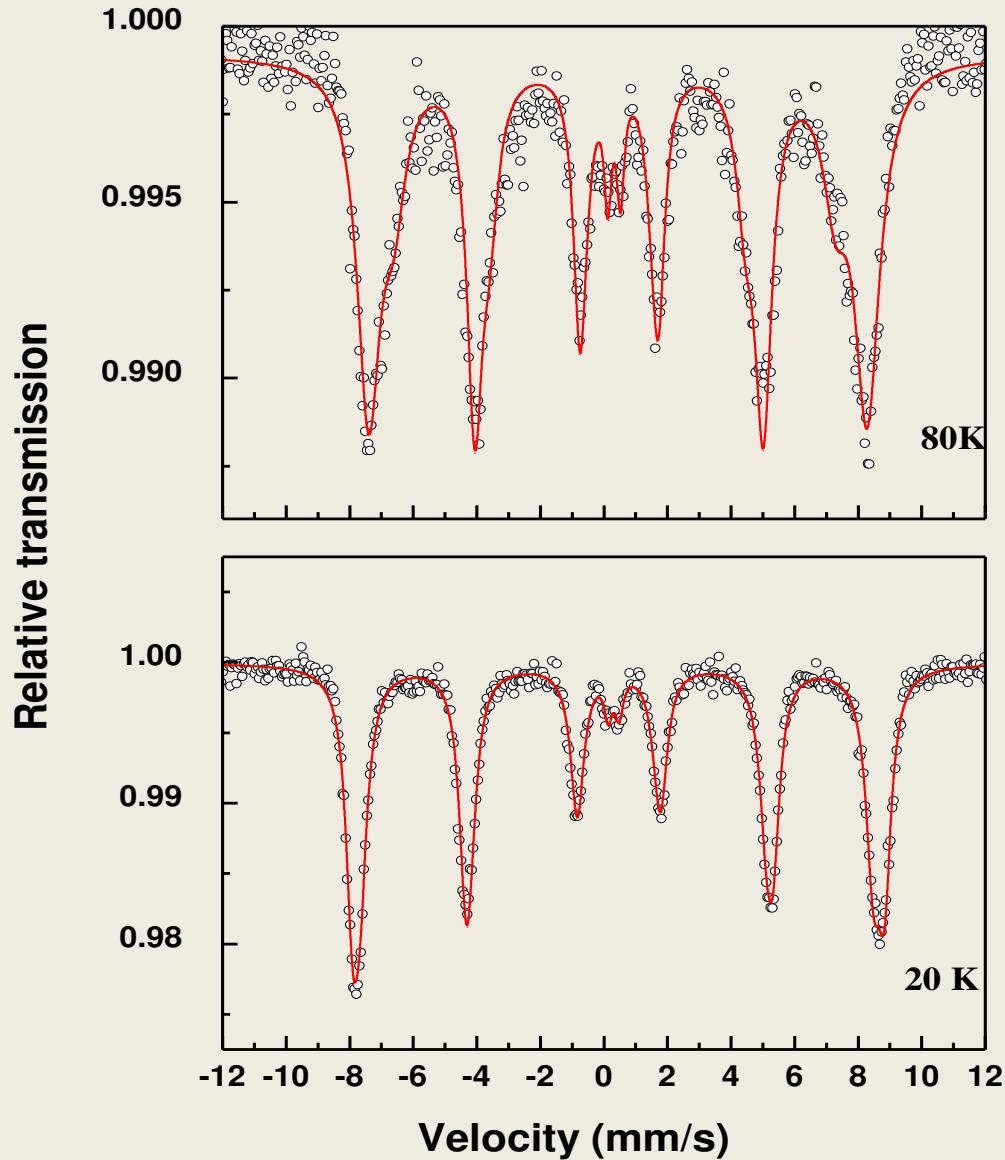
➡ Scherer formula $\rightarrow d_c = 13 \text{ nm} !$

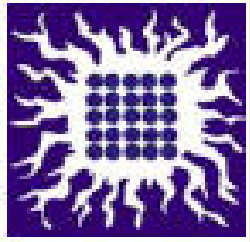


☀ ZFC/FC curves of the sample II, inset: hysteresis.

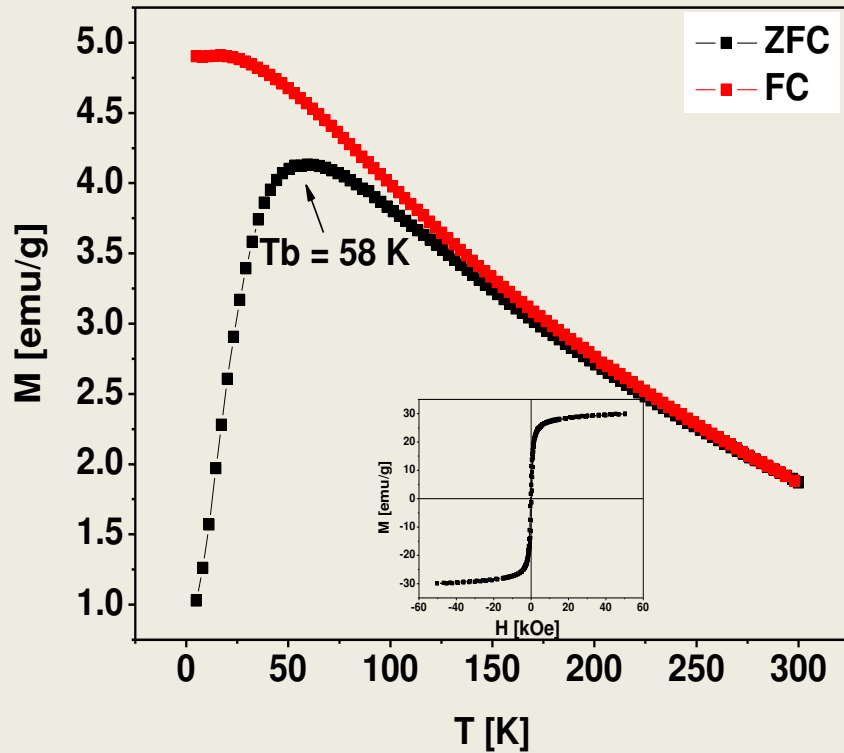


Sample II: Mossbauer spectra

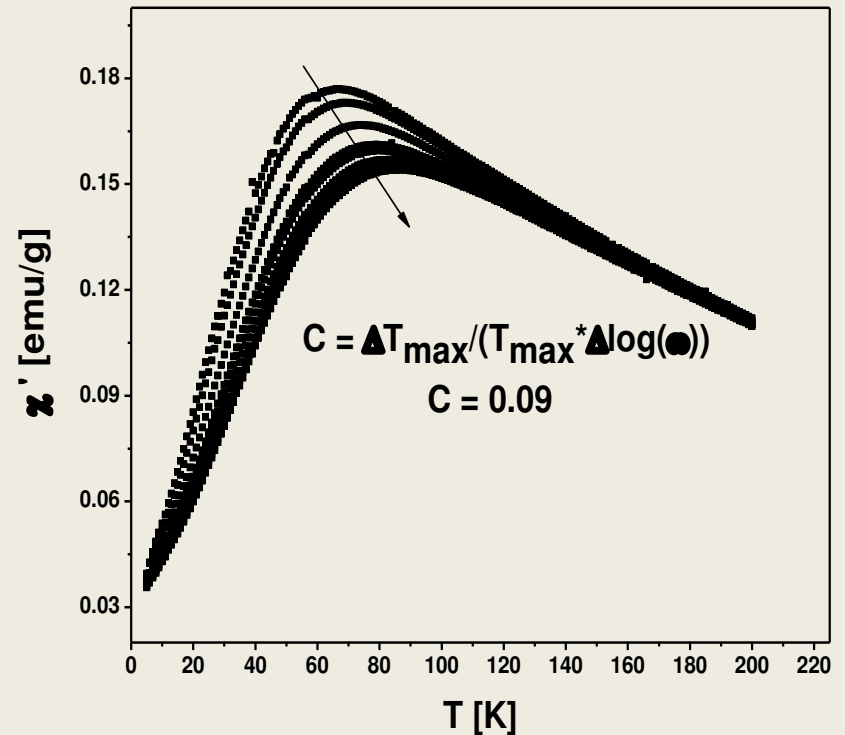




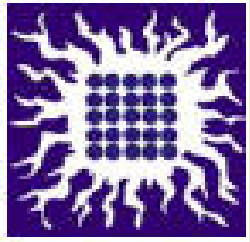
Sample III: DC and AC magnetic measurements



☀ ZFC/FC curves of the sample III, inset: hysteresis.



🌀 AC magnetic measurements



Conclusions from the synthesis

Ⓢ ***I sample*** – bulk Fe_3O_4

✱ ***II sample*** – nano Fe_3O_4

advantage : addition of the H_2SO_4 enable limited growth of the particles

disadvantage : wide particle size distribution

✱ ***III sample*** – nano Fe_3O_4 with advanced properties for hyperthermia use

advantage : narrow particle size distribution

next step : to make a ferrofluid



Questions?

Thanks for attention !!!