

Iron oxide nanoparticles with superior properties for theranostics



D. Bonvin^a, J. Bastiaansen^{b,c}, M. Stuber^{b,c}, M. Ebershold Mionic^{a,b,c}, H. Hofmann^a



^aPowder Technology Laboratory, Ecole polytechnique fédérale de Lausanne (EPFL), Switzerland; ^bCenter for Biomedical Imaging (CIBM), Lausanne, Switzerland; ^cDepartment of Radiology, Univeristy Hospital (CHUV) and University of Lausanne (UNIL), Switzerland

Introduction

Lately, **iron oxide nanoparticles (IONPs)** have been the focus of intense clinical research, especially for theranostics where IONPs act both as contrast agents for magnetic resonance imaging (MRI) and as heating sources for tumor elimination.

The aim was to develop IONPs in aqueous solution with controlled properties (shape, size, crystallinity, saturation magnetization) for theranostics.

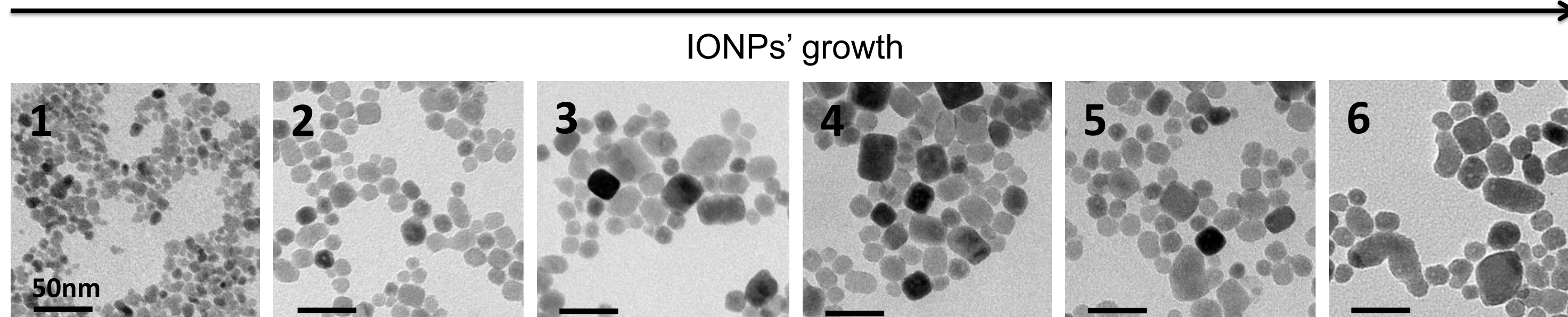
Conclusions

We report the synthesis of IONPs with controlled size, crystallinity and magnetic properties. We obtained IONPs with superior properties for theranostics, i.e. high relaxivities for MRI (r_2 and r_2/r_1 two times higher than the commercial contrast agent Resovist at 3T) and high SAR for hyperthermia (at clinically relevant field parameters).

Results

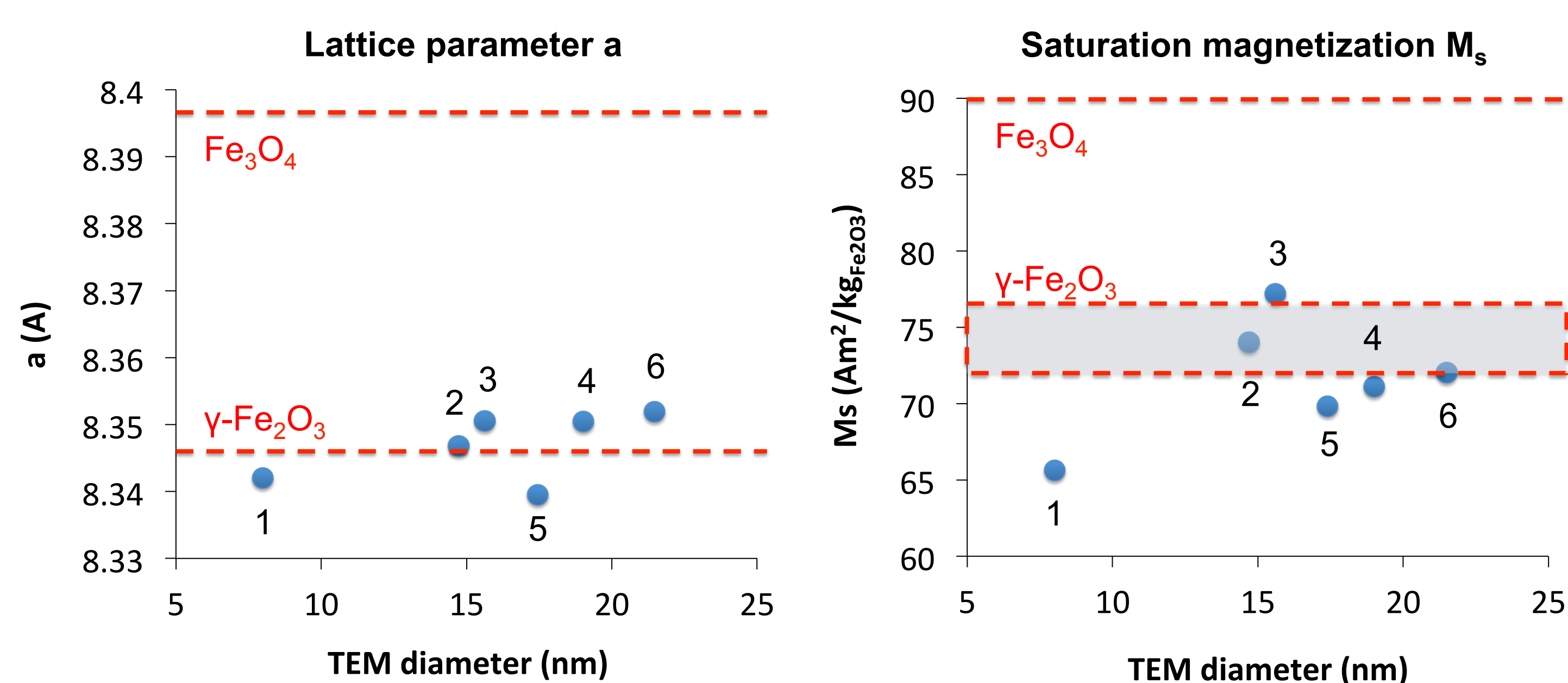
IONPs' size and shape, composition, crystallinity

Size evolution during IONPs' synthesis

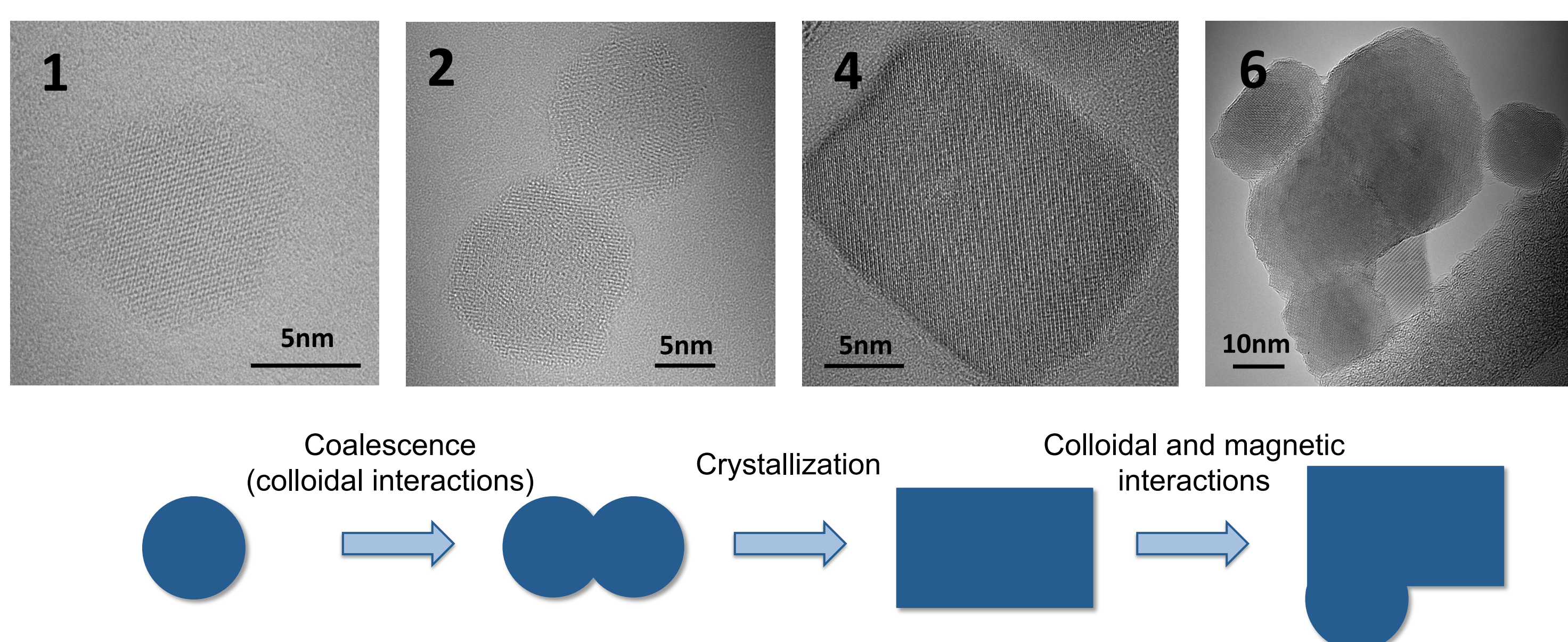


Samples	TEM diameter (nm)	Hydrodynamic diameter (nm)	Crystalline diameter (nm)
1	8.0 ± 1.9	16.1 ± 4.5	8.2
2	14.7 ± 5.0	26.9 ± 8.5	16.6
3	15.6 ± 4.7	29.5 ± 8.5	18.0
4	19.0 ± 5.7	25.8 ± 7.8	16.8
5	17.4 ± 4.7	35.1 ± 10.6	21.8
6	21.5 ± 6.3	30.2 ± 9.1	22.4

Composition of IONPs being closer to γ -Fe₂O₃ than Fe₃O₄

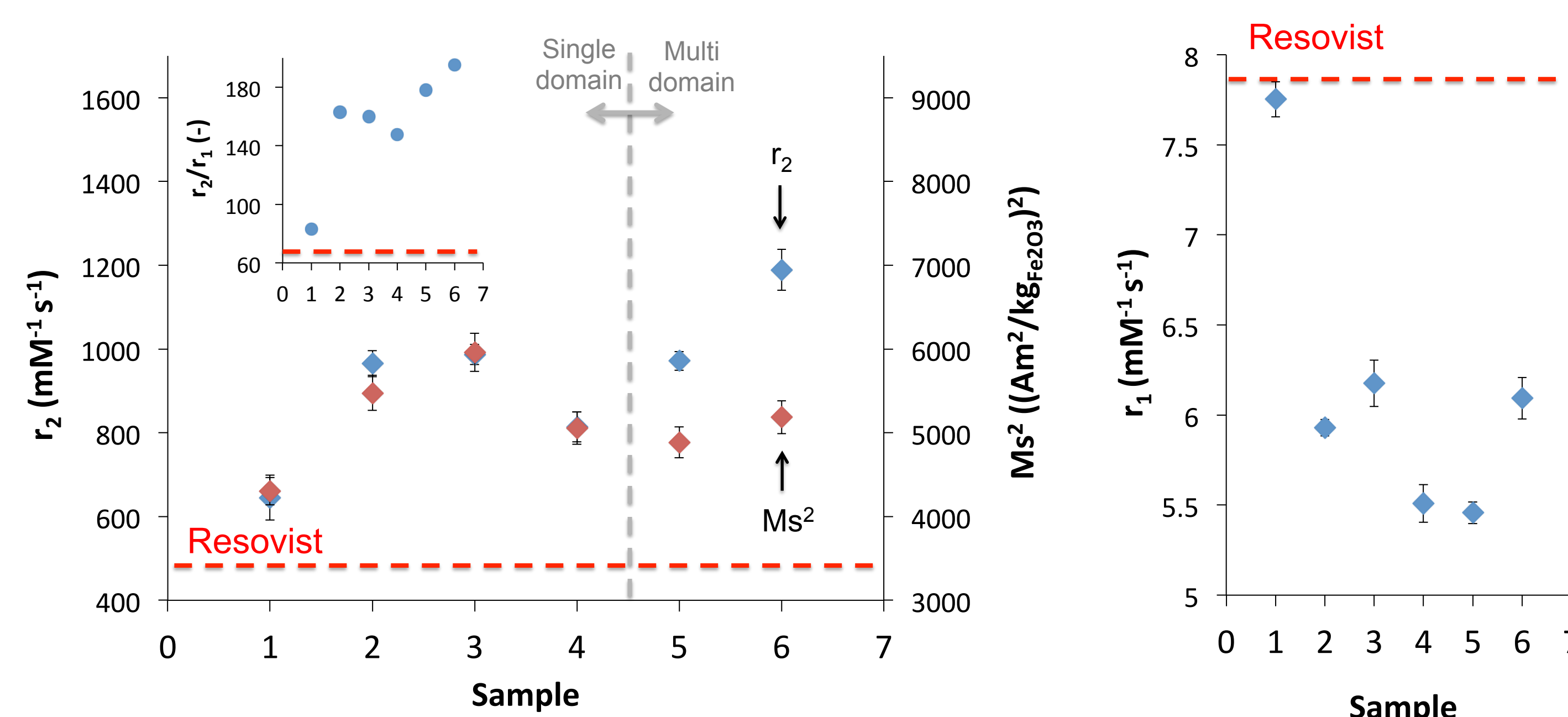


Growth mechanism during IONPs' synthesis related to the IONPs' size/shape and crystallinity evolution

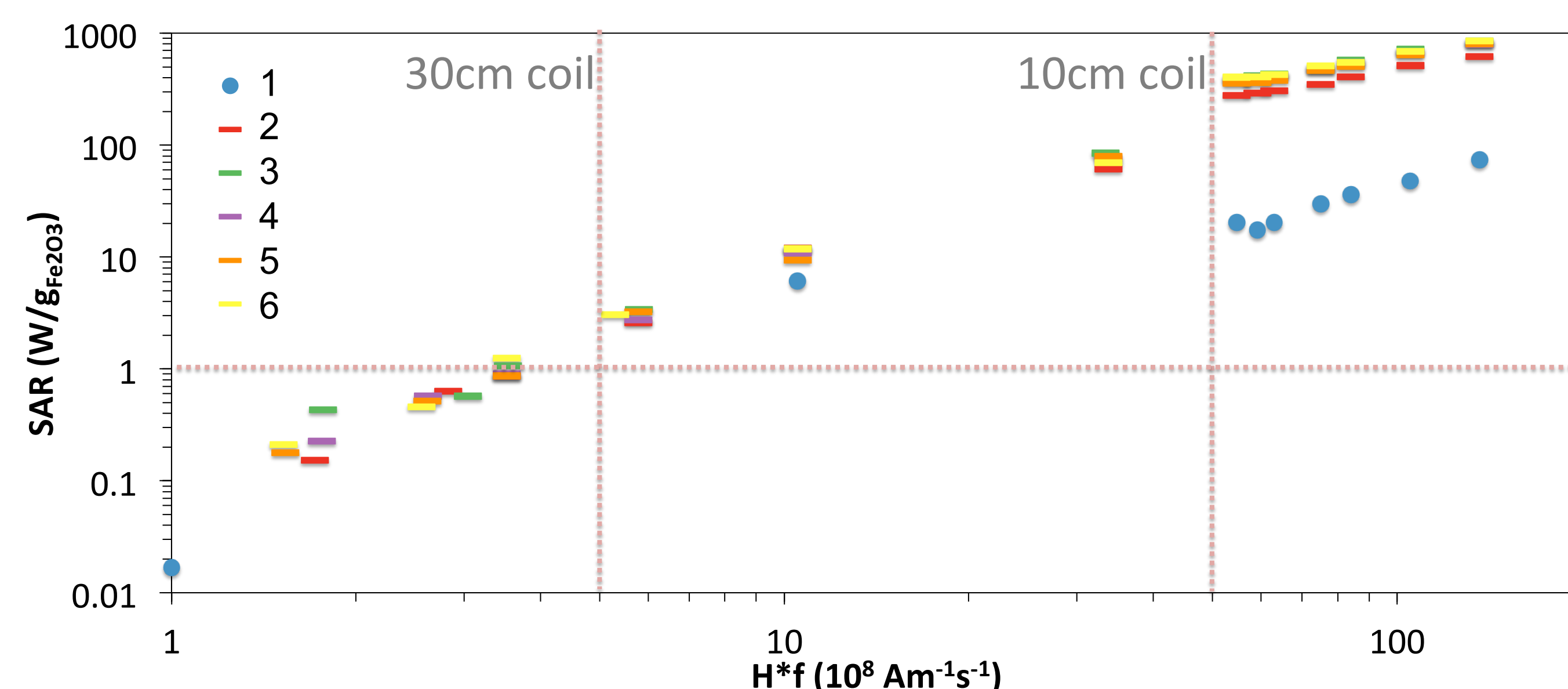


IONPs' properties for theranostics

MRI transverse (r_2) and longitudinal (r_1) relaxivity, as well as relaxivity ratio (r_2/r_1) of IONPs at clinically-applicable field (3T), as compared to the commercially available contrast agent Resovist



Heating capacity of IONPs for hyperthermia (specific absorption rate SAR) at field strength H and frequency f in clinically-applicable H*f (given by dashed lines for 10cm and 30cm magnetic coils)



Intrinsic loss power (ILP; SAR normalized with f^*H^2) at different magnetic fields for H*f in the clinical range (given by dashed lines)

