Influence of Magnetic Field on Nucleation of Thermally-induced Phase Transition in $La(Fe_{0.88}Si_{0.12})_{13}$

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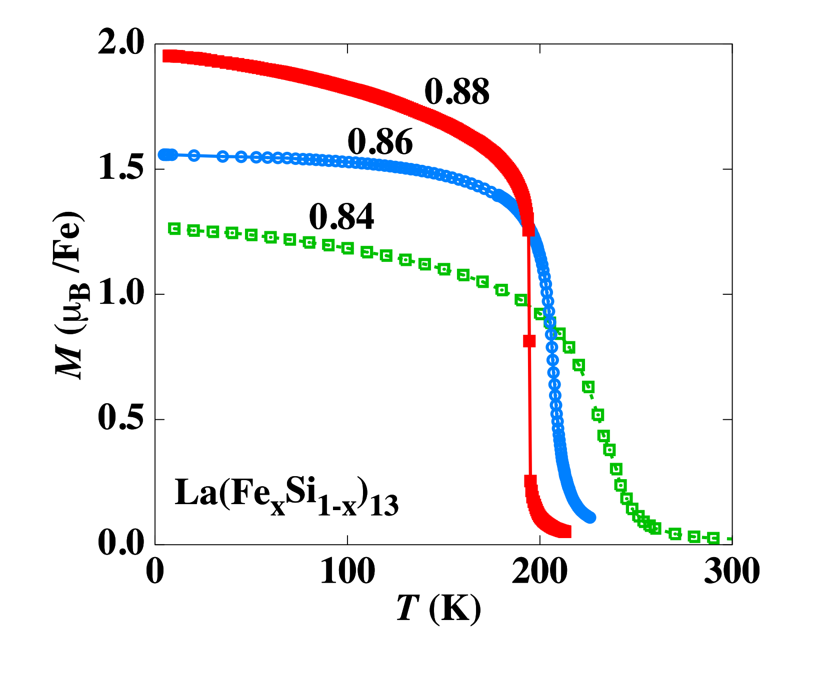
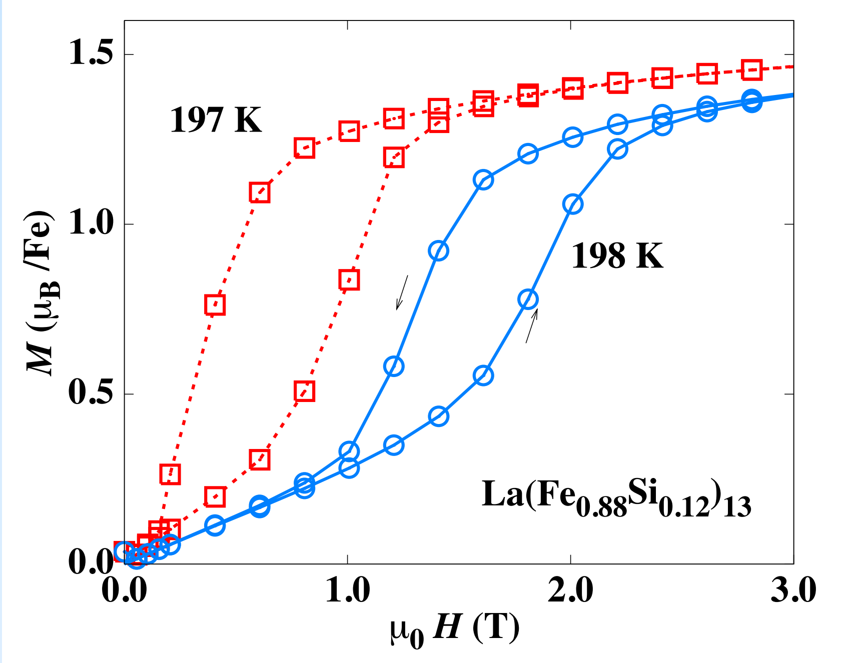


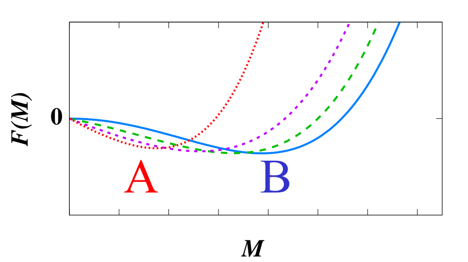


A. Fujita, Y. Akamatsu and K. Fukamichi, J. Appl. Phys. **85** (1999) 4756.

Why kinetics ?

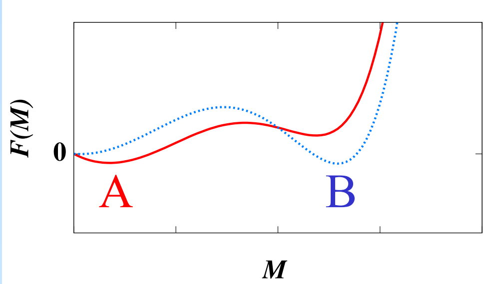
For the 1st order phase transition

*** No homogeneous ΔS_m and ΔT_{ad}**



* 2nd-order

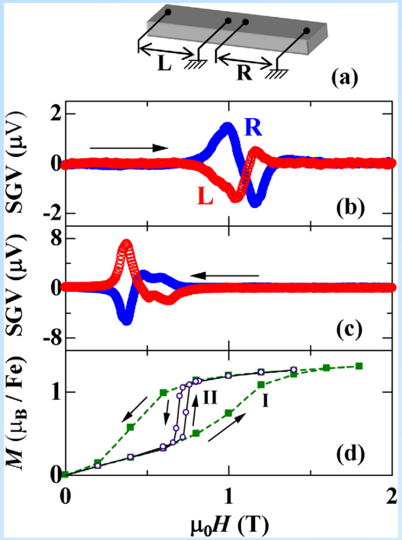
Route from
state A to state B
is continuous.
"Isothermal" or
"Adiabatic" path : OK

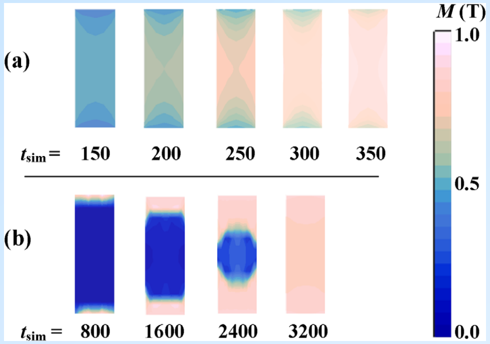


* 1st-order

Even if
A and B have
same S or T
inter-state transition
is terminated
by energy barrier

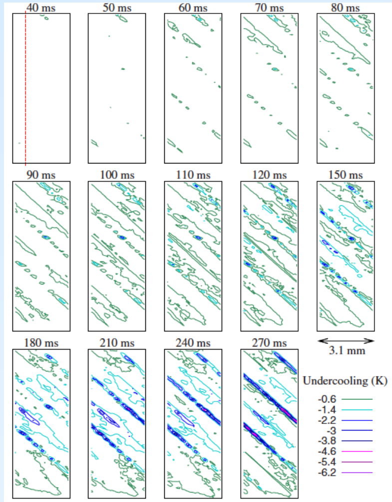
$La(Fe_{0.88}Si_{0.12})_{13}$



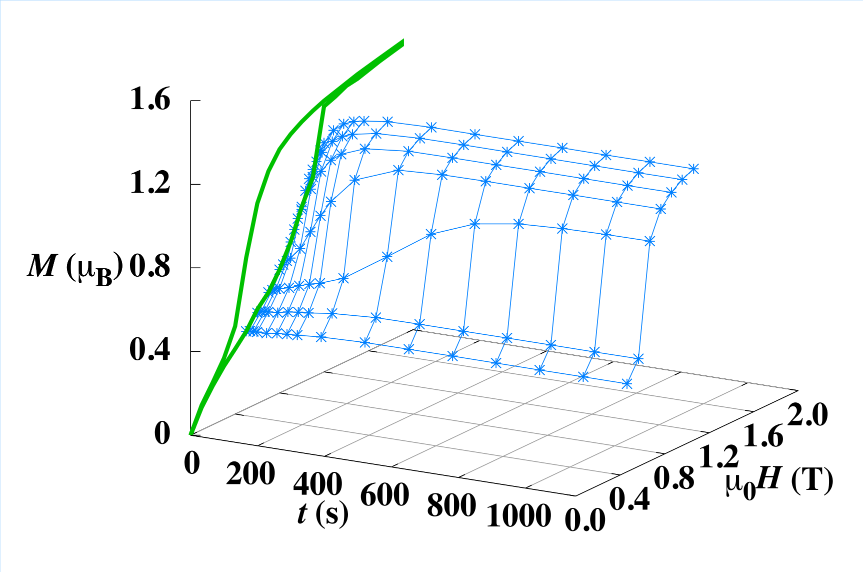


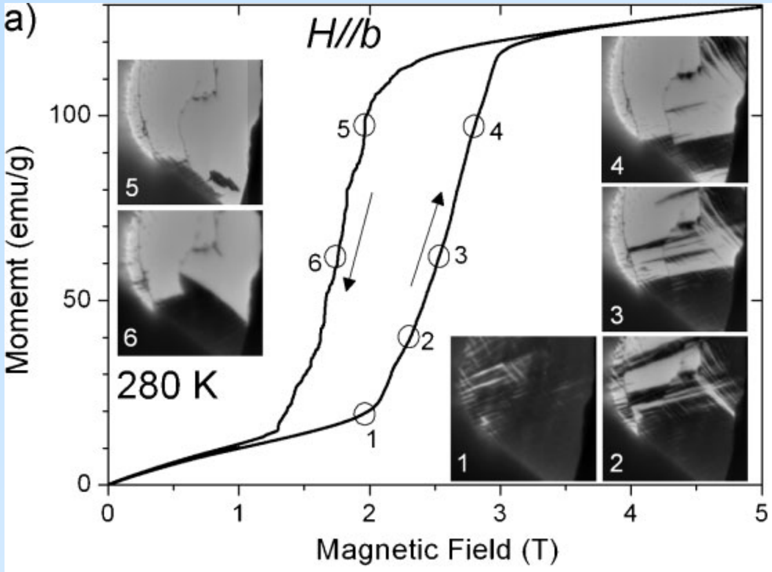
Fujita et al., Apl. Phys. Lett. **102** (2013) 041913.

Cu-Zn-Al



Vives, Mañosa, Planes et al.
Apl. Phys. Lett. **98** (2011) 011902.





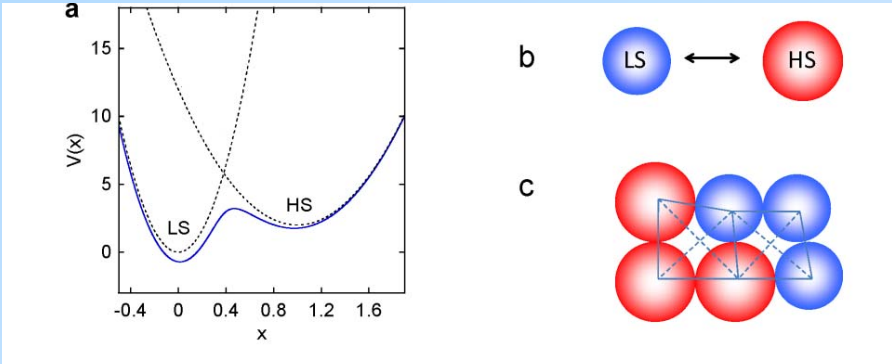
$La(Fe_{0.88}Si_{0.12})_{13}$
Yako and Fujita, IEEE Trans. Magn., **47**(2011) 2482 ,

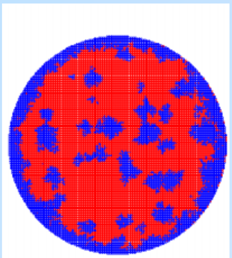
“Iso-field”

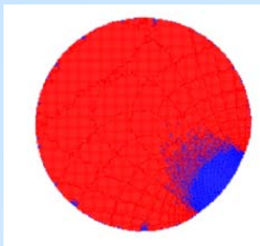
$Gd_5Ge_2Si_2$
Moor et al, Adv. Mater., **21**(2009), 3780

“ a-field ?? ”

Spin crossover





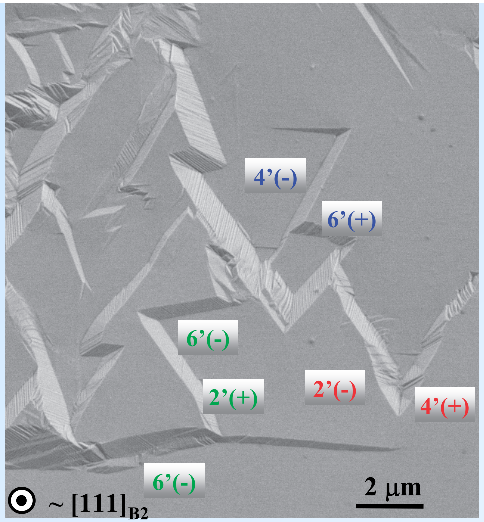


SRO model

SRO+LRO

Nishino, Miyashita et al
Sci. Rep. 1 (2011) 162

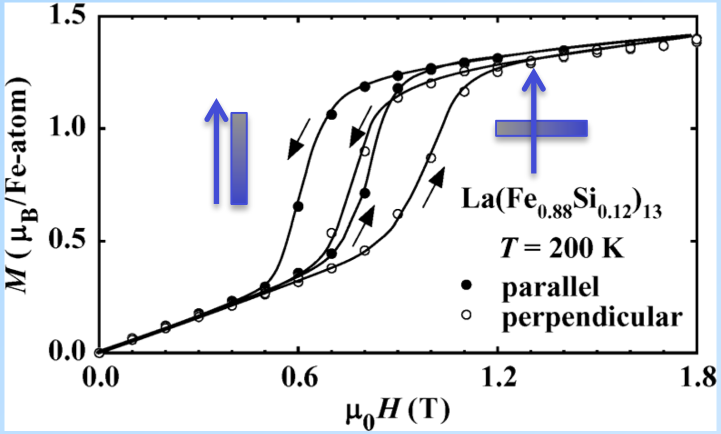
Long-distance strain-connected morphology in Ti-Ni martensite



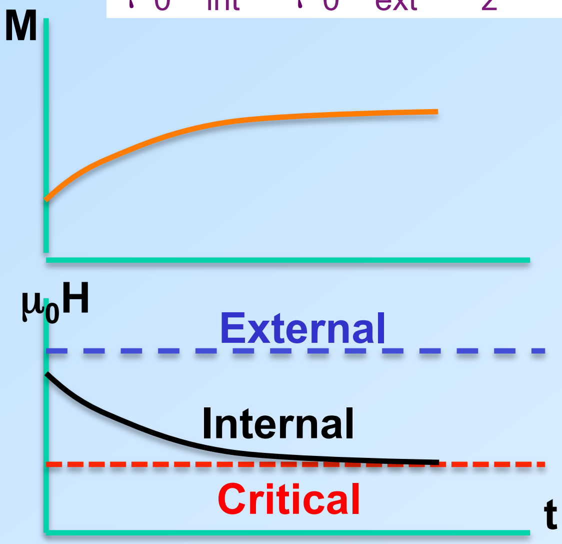
Nishida et at, Phil. Mag. 92 (2012) 221

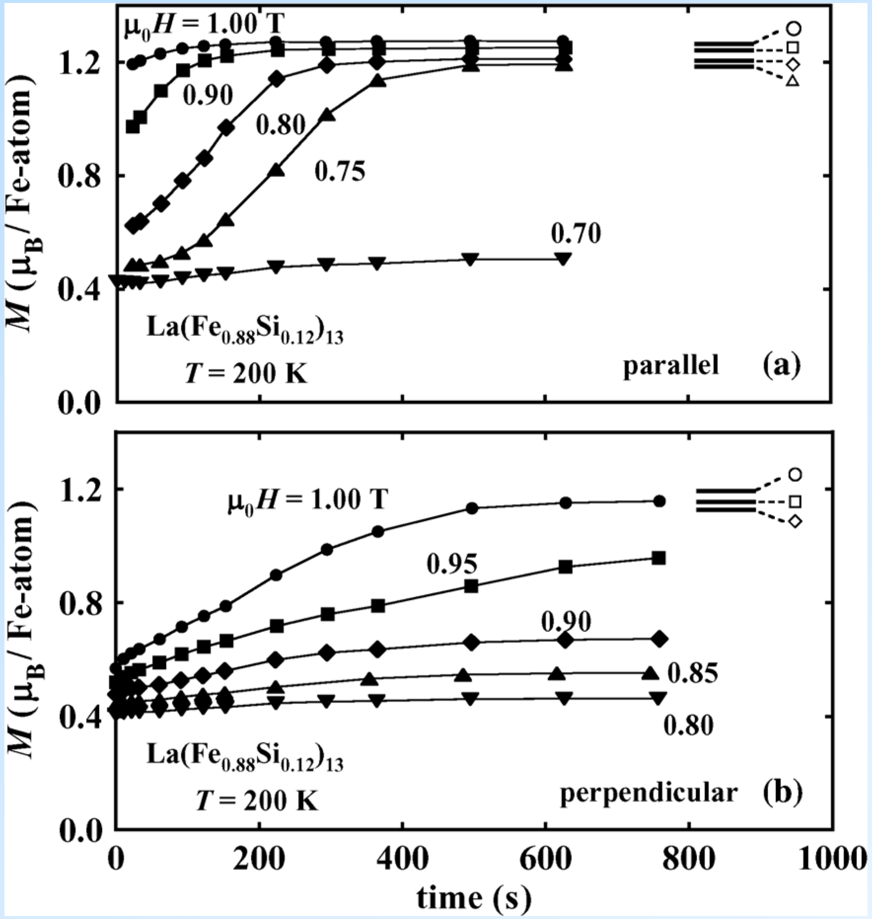
"Shape anisotropy" in kinetics

1mm * 1mm * 4mm
rectangular parallelepiped



$\mu_0 H_{int} = \mu_0 H_{ext} - D_z M$

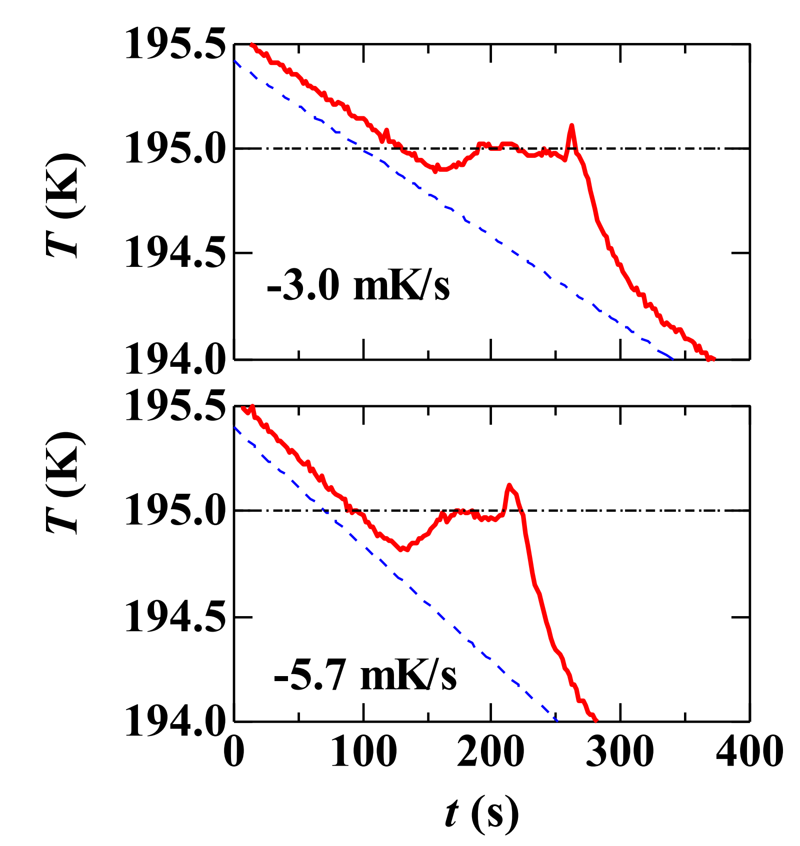


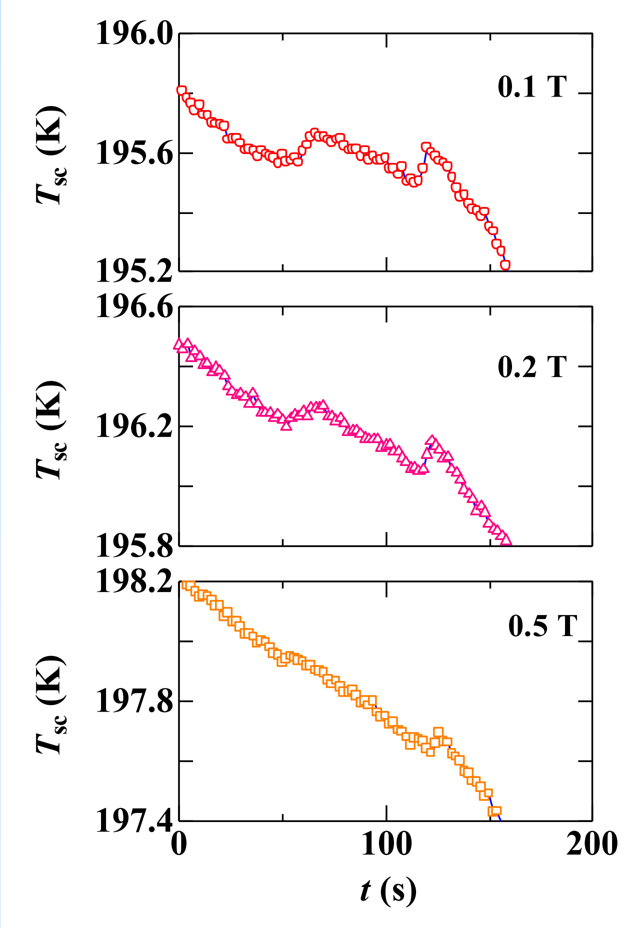


Yako and Fujita, IEEE Trans. Magn. 47 (2011) 2482

Value of unfinished M corresponds to $\mu_0 H_C - \mu_0 H_{int}$ by using "bulk" Dz value (instead of nuclei-shape one)

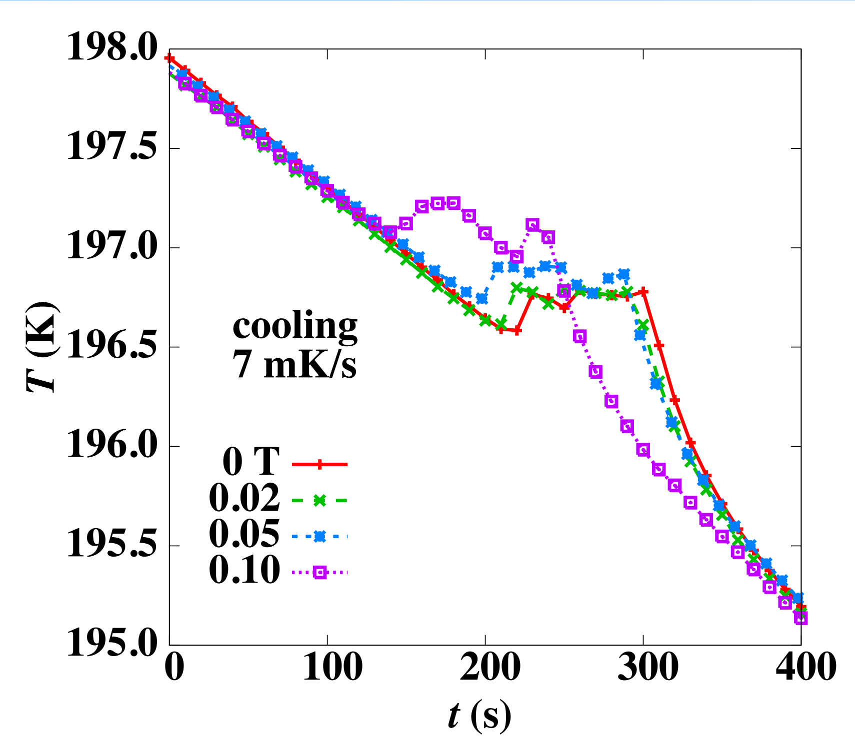
Supercooling feature

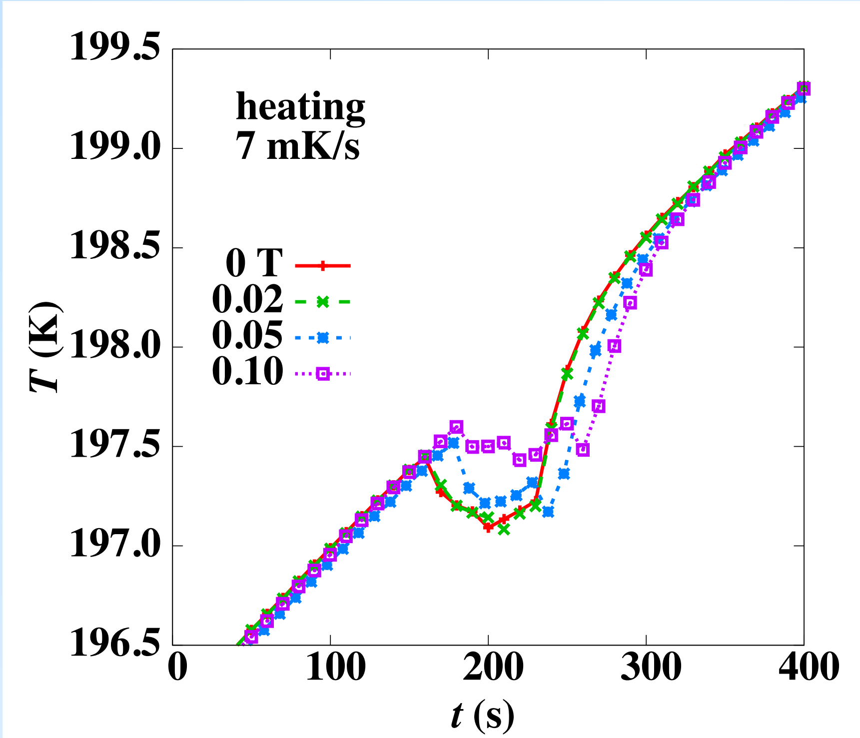




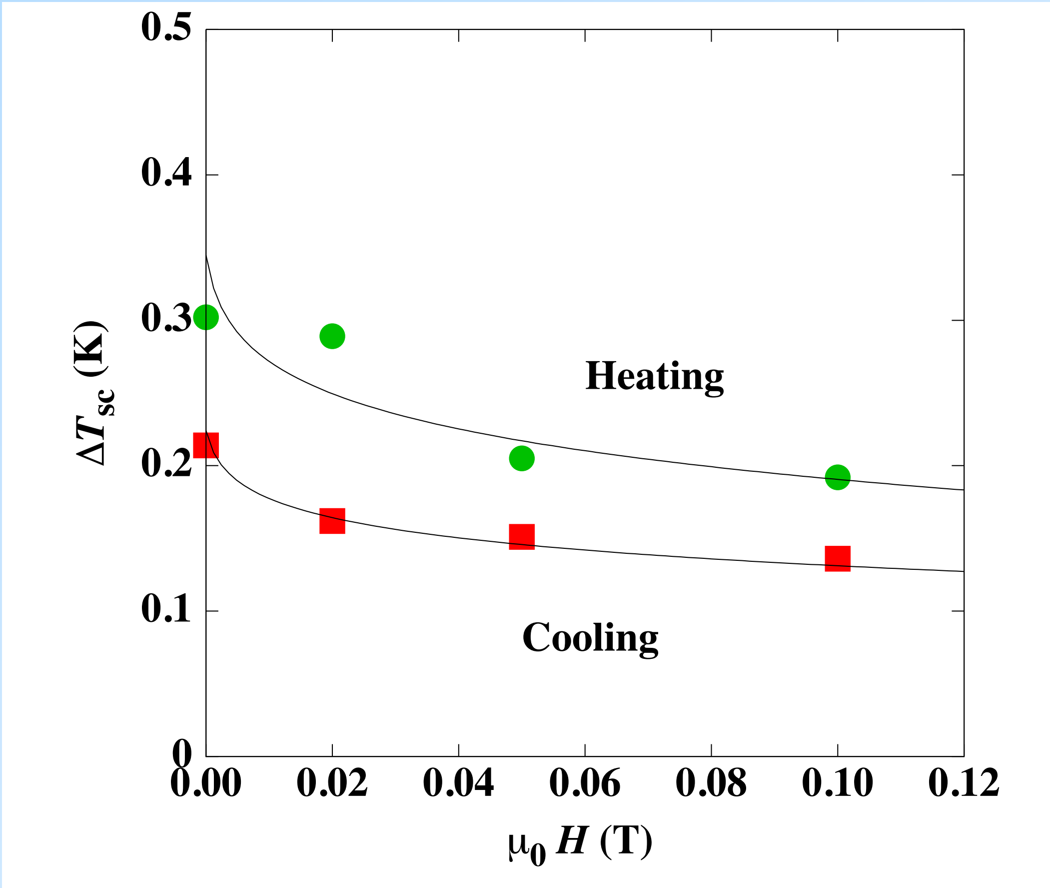
Fujita et al. IEEE Trans. Magn. 47 (2011) 3387

Supercooling(heating) profile under mag. field





Magnitude of undercooling



Classical model

$$\frac{2r_c}{\Delta T_{sc}} = A\exp\left(-\frac{\Delta G}{k_B T}\right)$$

$$\Delta G = \frac{16\pi\gamma^3}{3L^2}\left(\frac{T_C}{\Delta T_{sc}}\right)^2$$

L: latent heat $\quad\gamma$: surface energy

T_C: Curie temp. $\quad k_B$: Boltzmann const.

ΔT_{sc}: Magnitude of under cooling

r_c : Temeperatue sweeping speed

A: pre-exponential factor

Large difference of dipole distribution ???

Para. → Ferro.
Nucleation first occurs, then *magnetic domain* is formed after enough growth of the Ferro. region

Ferro. → Para.
Nucleation occurs in the Ferro. region including *magnetic domain*.

Magnetic fluctuations ???

Incubation from embryo to nuclei is reflects magnetic fluctuations

Magnetic field suppress the paramagnetic fluctuations

Conclusion

Nucleation behavior is characterized under magnetic field in $La(Fe_{0.88}Si_{0.12})_{13}$

1. Supercooling (heating) behavior shows different characteristics in cooling and heating processes.

2. By applying external magnetic field, magnitude of undercooling becomes smaller in both the cooling and heating process.

3. These change caused by magnetic field is explained by change in surface energy loss of nuclei in the conventional model.

Magnetostatic information, such as flux distribution of nuclei surrounded by magnetic domains, is necessary to reveal the nucleation-growth properties in magnetic fields (the AMR situations).