Large-scale simulation of $L1_0$ FePt nanoparticle toward magnetic recording

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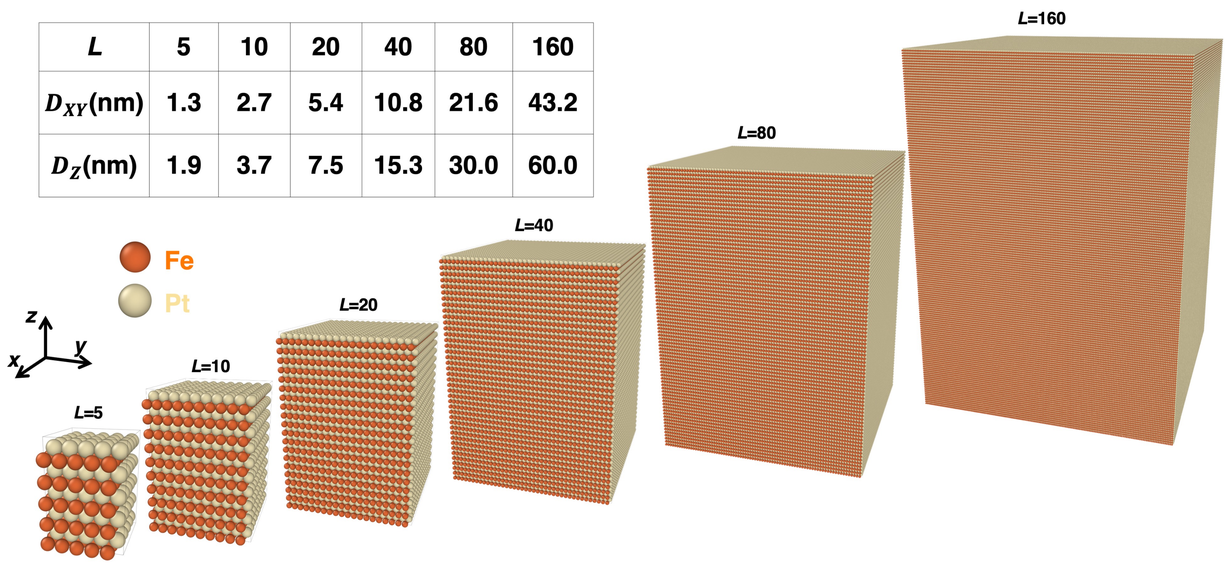
Introduction

L	5	10	20	40	80	160
D_{XY}(nm)	1.3	2.7	5.4	10.8	21.6	43.2
D_Z(nm)	1.9	3.7	7.5	15.3	30.0	60.0

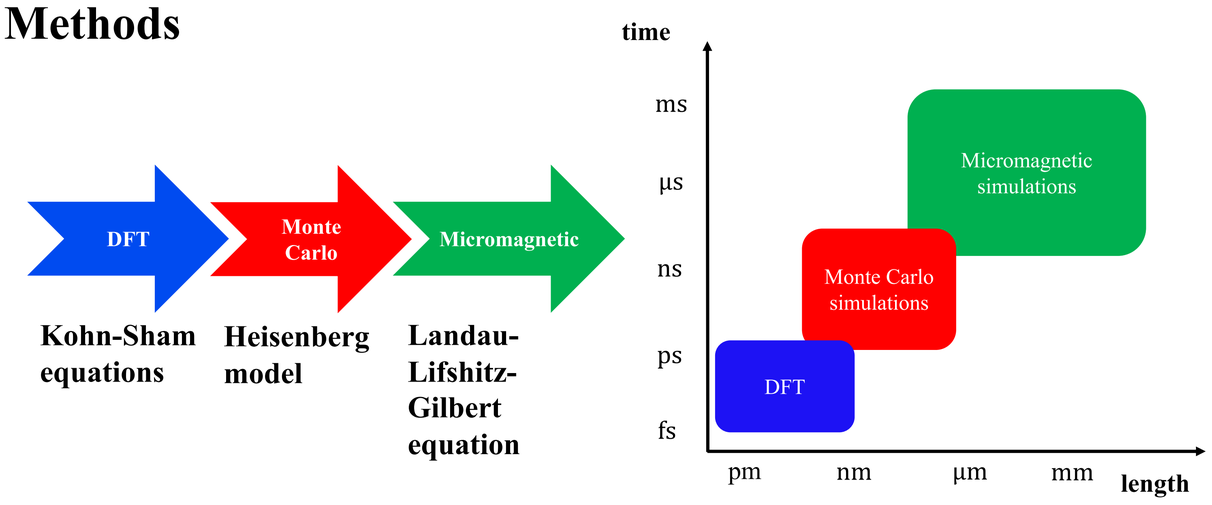


Energy barrier for magnetic flips of $L1_0$ FePt nanoparticle is important factor for magnetic recording applications [1-4]

Purpose

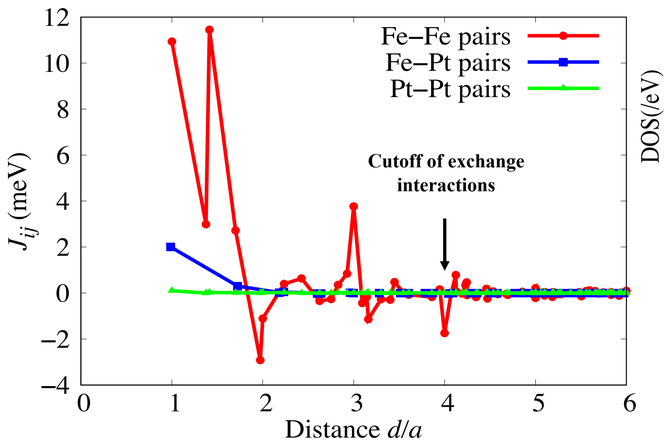
To develope large-scale simulation for $L1_0$ FePt nanoparticle toward magnetic recording applications.

Methods

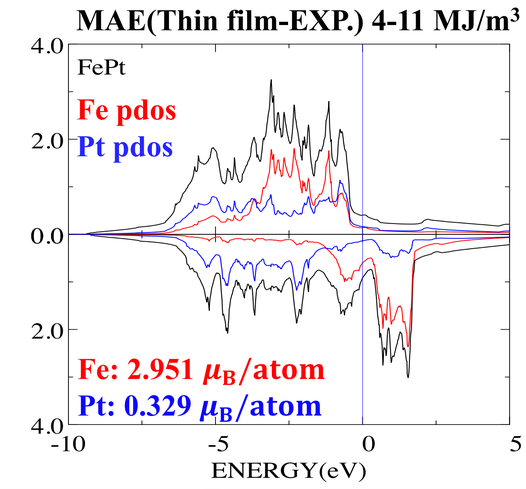


Results and Discussions

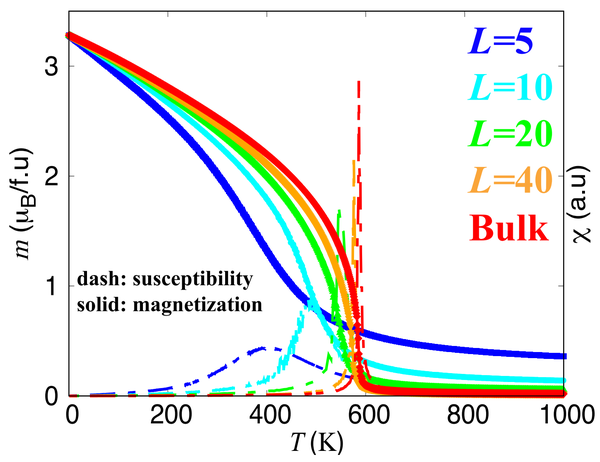
First-principles calculations for $L1_0$ FePt bulk

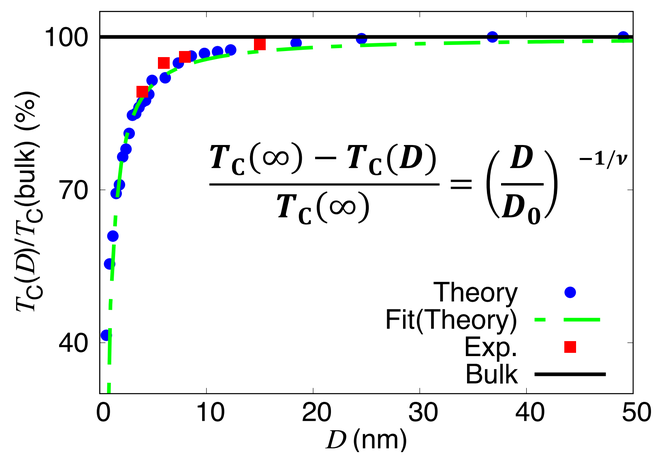


MAE(Bulk-DFT) 14.4 MJ/m^3
MAE(Thin film-EXP.) 4-11 MJ/m^3

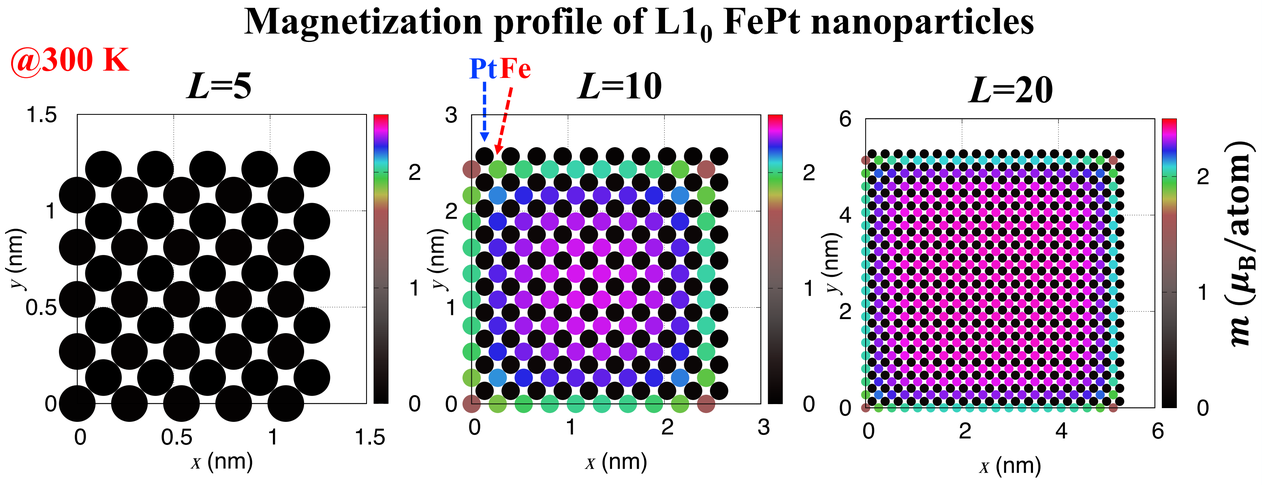


Size effect on Curie temperature of $L1_0$ FePt nanoparticles

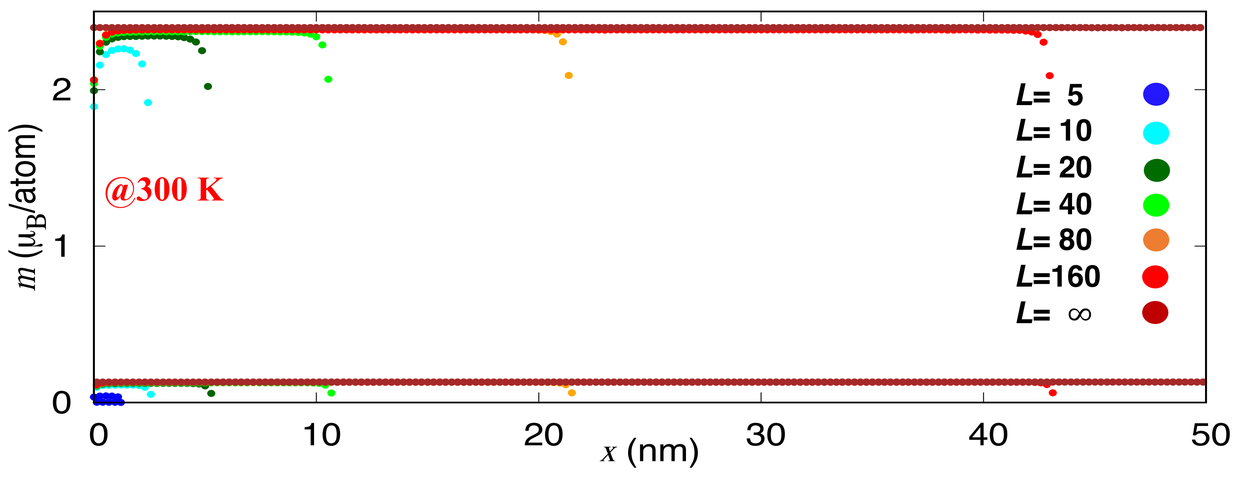




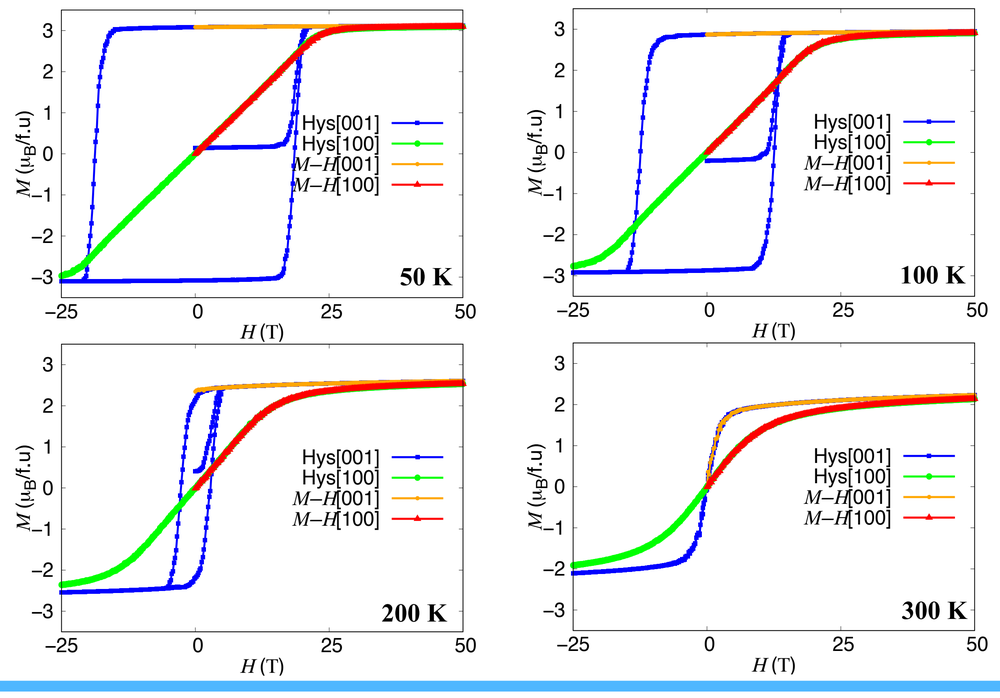
Magnetization profile of $L1_0$ FePt nanoparticles



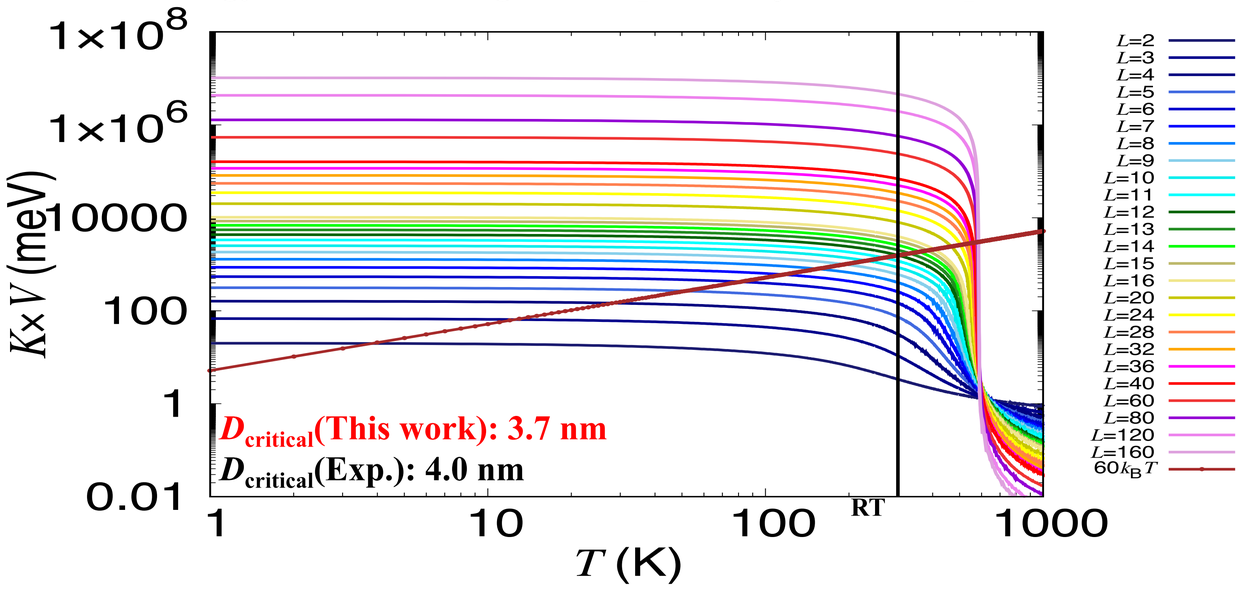
Magnetization layer-resolved of $L1_0$ FePt nanoparticles



Hysteresis loop and *M-H* curves of $L1_0$ FePt nanoparticles



Energy barrier of magnetic flips of $L1_0$ FePt nanoparticles



$K \times V \approx 60 k_B T$ (10 years)

Empirical rule base on Arrhenius-Néel equation
$\tau = \tau_0 e^{\frac{KV}{k_B T}}$ ($\tau_0 \cong 10^{-9} - 10^{-10}$ second)

Conclusions

Developement of large-scale simulation of $L1_0$ FePt nanoparticle for magnetic recording

The experimental results of resistivity and Curie temperature are well reproduced by our methodology

The $L1_0$ FePt nanoparticles, which have diameter less than 3.7 nm, can not store data more than 10 years

Papers of this study

[1] H. B. Tran, H. Momida, Y. Matsushita, K. Sato, Y. Makino, K. Shirai, T. Oguchi, *Phys. Rev. B* **105**, 134402 (2022).
[2] H. B. Tran, H. Momida, Y. Matsushita, K. Shirai, T. Oguchi, *Acta Mater.* **231**, 117851 (2022).
[3] H. B. Tran, Y. Matsushita, *Appl. Mater. Today* **32**, 101825 (2023).
[4] H. B. Tran, Y. Matsushita, "*Temperature and size dependence of energy barrier for magnetic flips in L10 FePt nanoparticles: First-principles study*", DOI: 10.2139/ssrn.4462256 (2023)