

# Functional Magnetic Materials; from permanent magnets to data storage



Keywords: Microstructure, Coercivity, hysteresis, Grain Boundary, Interface

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## Background

- High performance permanent magnets without reliance on scarce elements for energy conversion and transportation.
- Energy assisted magnetic recording for the next generation magnetic recording.
- Magnetic refrigeration

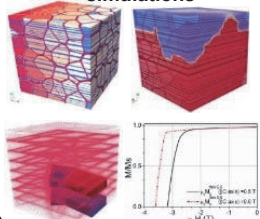
## Aim

- Development of a high coercivity permanent magnet with high maximum energy product  $(BH)_{\max}$  without reliance on heavy rare earth elements.
- Microstructure design and developments of energy assisted magnetic recording for hard disk driven (HDD) with a higher areal density.
- Microstructural origin of thermal hysteresis in the magnetocaloric compounds.

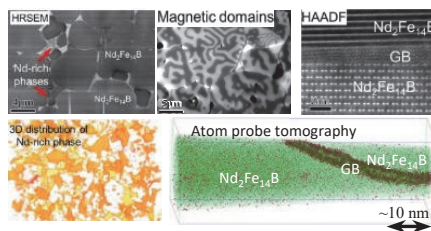
## Advanced Research Topics

### Development of high performance permanent magnets

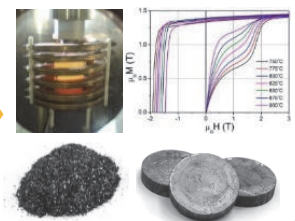
#### Large scaled micromagnetic simulations



#### Multi-scale microstructure characterizations

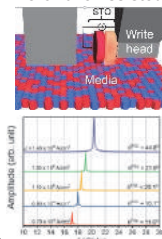


#### Materials Processing

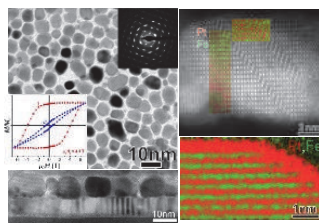


### Energy assisted magnetic recording

#### Spin-Torque-Oscillator design for Microwave Assisted Magnetic Recording

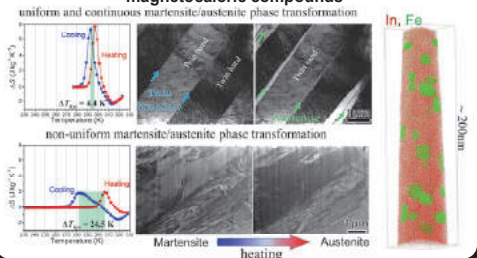


#### Media design for Heat Assisted Magnetic Recording



### Magnetic refrigeration

#### Microstructure origin of thermal hysteresis in the magnetocaloric compounds



## Publications

- Xin Tang, H. Sepehri-Amin, *et al.* Scripta Mater. 147 (2018) 108.
- H. Sepehri-Amin *et al.*, "Microstructure, coercivity, and in-plane component of FePt-C granular films deposited on MgO, MgTiO<sub>x</sub>, and MgTiON under-layers" Scripta Mater. (2018) in-press.
- H. Sepehri-Amin *et al.* Acta Mater. 147 (2018) 342-349.

## Summary

- Development of Dy-free permanent magnet with high coercivity and high  $(BH)_{\max}$ .
- Design and development of media and spin-torque-oscillator for the energy assisted magnetic recording for high areal density HDD.
- Microstructure origin of hysteresis in Heusler magnetocaloric compounds.

## Research outcome

- Development of high coercivity and high remanence Dy-free Nd-Fe-B magnets.
- Design and development of mag-flip STO device with oscillation frequency above 20 GHz..
- Underlayer for FePt-(C,SiO<sub>2</sub>) granular media.
- Microstructure origin of hysteresis in Ni-Mn-based magnetocaloric compound.