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Development of new Fe-based magnetic materials by controlling crystal structure

Research Project Outline (From Apr. 2011 to Mar. 2016)

Development of new Fe-based magnetic materials with high magnetocrystalline anisotropy,

◎To study on the possibility for controlling crystal structure of materials by thin film, nanoparticle, and high pressure techniques.

◎To develop nanocomposite magnets based on hard and soft magnetic phases.

→New Fe-based magnetic materials can improve magnetic devices, which leads to rare earth saving and the development of low carbon society.

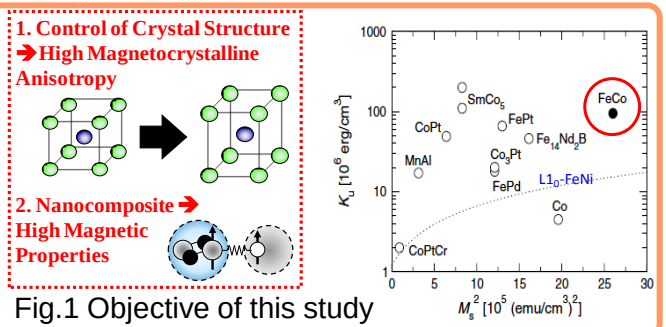

Fig.1 Objective of this study

Research Results (FY2013)

◆Possibility of Fe-based materials with high magnetic properties

○ Phase diagram:

✓We calculated c/a-dependence of free energies in the Fe-Co-Ni ternary system, and investigated the thermodynamic stability of tetragonal Fe alloys with about c/a=1.25.

✓We calculated formation enthalpies of Fe-based Heusler alloys considering a combination of various elements and evaluated their magnetic properties such as the coercive forces using first-principles calculations.

Development of the method of calculating any unstable state and confirmation of several stable Fe-based Heusler alloys

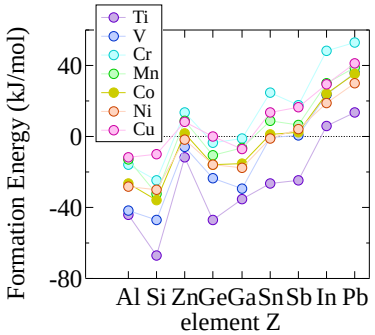

Fig.2 Formation enthalpies of Fe-based Heusler alloys

◆Search for new alloys and compounds

○ Thin Film, Powder & Nanoparticle Techniques:

✓ We succeeded to prepare nanoparticles such as FeCo, FePt, $SmCo_5$, and MnBi, for nanocomposite magnets.
K. Isogai et al., ***Mater. Trans***, 54 (2013) 1673.

✓ We clarified that high coerecivity in the developed Mn-Sn-Co-N alloys is closely related to the twin density in the perovskite-type phase.
M. Matsuura et al., ***J. Alloy. Comp.***, 605 (2014) 208.

Prparation of nanoparticles for nanocomposite magnets and clarification of relation between microstructure and HcJ in Mn-Sn-Co-N

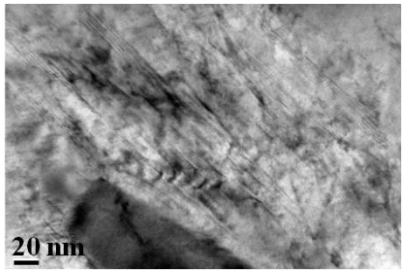

Fig.3 TEM image of the Mn-Sn-Co-N alloy with high coercivity