【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)

Title of Project : Creation of Spin-Nanostructure with Extreme High Magnetic Moment

Migaku Takahashi
(Tohoku University, Graduate School of Engineering, Professor)

Research Area : Engineering, Electrical and electronic engineering, Electronic materials/Electric materials

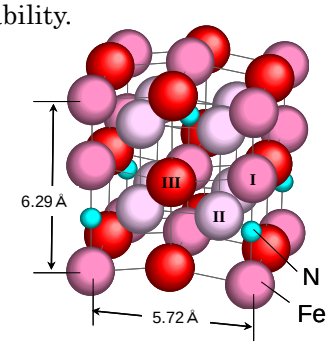
Keyword : magnetic material, saturation magnetization, iron nitride, nanoparticle, thin film

【Purpose and Background of the Research】

For the future information explosion era, high speed and massive information communication system needs miniaturized electric devices with low electric consumption, in addition to use of conventional natural resources for CO_2 gas suppression. Our final goal is to establish synthesis methods of the spin-nanostructure (nanoparticle) with extremely high saturation magnetization which has hardly overcome for 100 years due to its upper limit of the Slater-Pauling curve. Furthermore, we will develop a nano-assembly technology using the spin-nanostructure for possible applications to highly functionalized and performed electric devices.

【Research Methods】

In this research, we mainly focus on iron-nitride with possible high saturation magnetization. Especially, $Fe_{16}N_2$ phase (see the below figure) has high magnetocrystalline anisotropy field (10kOe) and high saturation magnetization (1880G) in spite of its meta-stability.

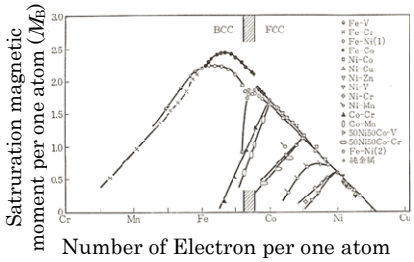


Crystalline structure of iron nitride.

Nano-crystalline size within several nm- several hundred nm in diameter, magnetically decoupled nanostructure and bulk form of cm order of nano-assembly will be one candidate of promising material for highly functionalized and performed electric devices. For developing the synthesis method of nitride nanoparticles, direct synthesis using ammonia gas and/or indirect synthesis using Fe_3O_4 nanocubes as a precursor nanostructure will be established through structural and magnetic characterizations, finally aiming to obtain spin-nanostructure with extremely high magnetic moment over 1880G.

【Expected Research Achievements and Scientific Significance】

The material research history for obtaining high saturation magnetization of magnetic materials has continued over 100 years. However, the upper limitation of the magnetization has been restricted by the Slater -Pauling curve.



Slater - Pauling curves.

Iron nitride nanoparticle with mainly $Fe_{16}N_2$ phase and with highly distorted crystalline structure along its a and c-axes simultaneously will provide a breakthrough toward the above problem.

【Publications Relevant to the Project】

・Takahashi and H.Shoji,"α"-$Fe_{16}N_2$ problem - giant magnetic moment or not – (invited)", *J. Magn. Magn. Mater.*, **208**, 145 (2000).
・Sunaga, M. Tsunoda, and M. Takahashi, Effect of Axial Ratio and Atomic Volume on Magnetism of α' and γ'-Fe-N", *IEEE. Trans. Magn.*, **42** (10), 3020 (2006).

【Term of Project】 FY2009-2013
【Budget Allocation】 157,400Thousand Yen
【 Homepage Address and Other Contact Information】
http://www.takahashi.ecei.tohoku.ac.jp/index.htm