【Grant-in-Aid for Scientific Research (S)】

Broad Section C

Title of Project： Establishment of the new method for material synthesis utilizing light elements and their expansion to develop rare- earth-free magnet

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【Purpose and Background of the Research】

The sales unit of world-wide x-EV (electric vehicles) is predicted to rise to 100 million across 50% of whole car unit in 2035. In addition, the rapid spread of robots and wind power generation are predicted, and the huge demand expansion of the permanent magnet necessary for a motor or generator constituting them is anticipated. There are only two kinds of permanent magnets now, one is ferrite which has low price and low magnetic properties, and the other is NdFeB magnet which has high price and high magnetic properties. Therefor it has been desired that the magnets where the cost performance is located between NdFeB and ferrite. In addition, as for the rare-earth elements such as Nd used for NdFeB alloy exist mostly in China, we can not wipe out the uncertainty of constant supply. Therefor the development of rare-earth-free magnet materials is necessary. Recently China raises a production technology of the NdFeB magnet and has come to already occupy two thirds of the worldwide production as showed

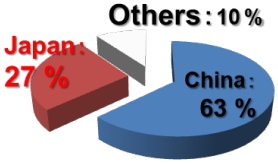

Fig. 1　Worldwide production of NdFeB magnet.

in Figure 1. So it comes urgent issues that “How does our country face with the huge demand of magnet by the rapid popularization of x-EV, wind power generation and robots and also the technical catch up by China ? ". We aim at continuing to be the world leader in the field of magnets by creating of rare-earth-free magnet materials having magnetic properties between NdFeB and ferrite magnet as showed in Figure 2.

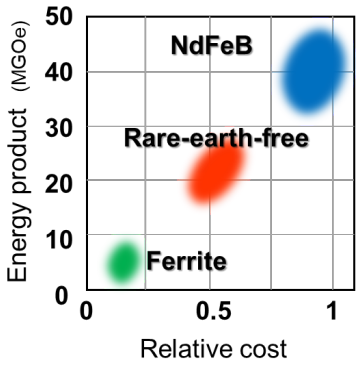

Fig. 2　Rare-earth-free magnet materials which is aimed in this research.

【Research Methods】

As a candidate of rare-earth-free magnet materials having magnetic properties between NdFeB and ferrite magnets, we will investigate the Fe alloy including the light element (H, C, O and N) interstitially. Theory group will try to predict the magnetism of these Fe alloys by the first principal calculation. On the other hand, experiment group will make efforts to introduce H, C, O, and N into Fe. In other words, we focus on the materials creation of the rare-earth-free magnet including the light element by combining a theoretical calculation and processing technique.

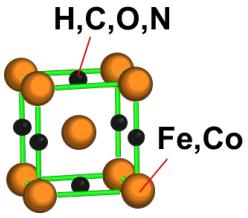

Fig. 3　Crystal structure of Fe-Co alloy including light element.

【Expected Research Achievements and Scientific Significance】

We will try to establish a new category by the development of the rare-earth-free magnet having a middle performance of NdFeB and the ferrite. It is significant strategy to win international competition through technical superiority of motor design technology of our country. If rare-earth-free magnet showing superior cost performance will be created, the market of magnets will change drastically.

【Publications Relevant to the Project】

・Y. Kota, A. Sakuma, Degree of Order Dependence on Magnetocrystalline Anisotropy in Body-Centered Tetragonal Eco Alloys, Appl. Phys. Express, 5, 113002 (2012)
・M. Tobise, S. Saito, M. Doi, Challenge to the synthesis of α”-$(Fe,Co)_{16}N_2$ nanoparticles obtained by hydrogen reduction and subsequent nitrogenation starting from α-(Fe,Co)OOH, AIP Advances JMI2019, 035233 (2019)

【Term of Project】 FY2019-2023

【Budget Allocation】 146,400 Thousand Yen

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