

Preparation of Nd based nano composite by reduction-diffusion process

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Rare earth (RE) - transition metal based high energy density magnets are of immense significance in various engineering applications. Nd based magnets possess the highest energy product and are widely used in whole industries. Simultaneously, composite alloys that are cheap, cost effective and strong commercially available have drawn great attention, because rare-earth metals are costly, less abundant and strategic shortage.

We designed rare-earth free alloys and fabrication process and developed novel route to prepare Nd based nanocomposite powders by wet process employing spray drying and reduction-diffusion (R-D) without the use of high purity metals as raw material. The novel route to prepare Nd-based nanocomposite powders by utilizing both spray drying and reduction-diffusion processes was designed and investigated in this study. Precursors were prepared by spray drying method using the aqueous solutions containing Nd salt, Fe salt and boric acid with stoichiometric ratios. Desalting of the precursors, milling and reduction in H₂ atmosphere were performed, followed by R-D process. It was revealed that the amount of Calcium (Ca) as reducing agent added in R-D step played an important role in the formation of Nd₂Fe₁₄B phase, because vigorous H₂ evolution and dissociated hydrogen might be diffused into the lattice of Nd₂Fe₁₄B interstitially to form Nd₂Fe₁₄BH_x (x=1-5) during washing of powders in water obtained after R-D with excessive amount of Ca. In order to make the powders smaller and homogeneous size, we carried out ball milling in ethanol before washing with water. Finally, Nd₂Fe₁₄B powders with high coercivity of more than 10 kOe were produced by adjusting the amount of Ca in reduction-diffusion (R-D) process. They showed spherical in shape with a mean size of 1 μ m and maximum energy product (BH)_{max} was attained 17.8 MGOe. It is considered that this process can be applied for the recycling of RE-elements extracted from waste magnets including motors.

References

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