Mechanochemical synthesis of $Nd_2Fe_{14}B$ particles with high coercivity from precusors prepared by spray drying process

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Since $Nd_2Fe_{14}B$ was first discovered by Sagawa et al.[1], many kinds of methods have been developed to fabricate Nd-Fe-B magnets, such as powder metallurgical, rapidly quenching and reduction-diffusion (R-D) process. Nowadays powder metallurgical and rapidly quenching methods are commonly used to fabricate Nd-Fe-B magnets. But, both of them consume additional energy and increase the production cost due to the use of high purity metals as raw materials. Meanwhile, the R-D technique which has been successfully used in producing $SmCo_5$ and $Nd_2Fe_{14}B$, proved to have many advantages in terms of energy consumption and production cost. In our study, $Nd_2Fe_{14}B$ alloy particles with high coercivity of more than 10kOe were successfully synthesized by adjusting the amount of Calcium(Ca) in R-D process. Calcium oxide (CaO) and unreacted Ca remained after R-D process in particles prepared by heat treatment in Hydrogen (H_2) atmosphere. In the ratio of 0.4 of Ca to powders(Ca/powders, wt%), residual Ca was not detected from X-ray diffraction pattern after R-D. On the other hand, Ca appeared above the ratio of 1.0 and below the ratio of 0.2, amount of Ca was not enough to reduce Nd oxide[2]. Moreover, excess Ca affected magnetic property of final products obtained after washing, because residual Ca gave rise to evolution of H_2 gas during disintegration in water and it led to the formation of $Nd_2Fe_{14}BH_x$ (x=1–5).

It is difficult to find a proper washing solvent which can remove by-product, CaO and to keep magnetic properties of Nd-Fe-B particles. We develop de-oxygen washing system which can remove dissolved oxygen in washing solvent. De-oxydized water, dilute acetic acid solution, and alkaline solution were used as washing solvent. Influence of different washing solvent on phase, morphologies, microstructures, composition, and magnetic properties of the powders were investigated.

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References

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