Magnetic properties of MnBi/$Sm_2Fe_{17}N_3$ hybrid sintered magnets using hot compaction process

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Permanent magnets (PM), the material for energy storage, have been used for a wide range of applications (consumer electronics, automotive, factory automation etc.). Among commercial PM products, NdFeB magnets have been widely used because they have the highest value of the maximum energy product at room temperature. However, NdFeB magnets have some problems, such as the limited resources of raw materials, and the degradation of magnetic properties in the high-temperature environment. In this respect, the development of new PM with excellent magnetic properties and thermal stability has attracted much attention due to a strong need in hybrid and electric vehicles.

There have been several efforts to develop sintered magnets using MnBi and $Sm_2Fe_{17}N_3$ compounds because a LTP (low temperature phase) MnBi compound possess a high anisotropy field and a positive temperature coefficient from -123 ~ 277℃[1] and a $Sm_2Fe_{17}N_3$ compound an excellent maximum energy product. However, the LTP MnBi has a relatively low saturation magnetization (80 emu/g) and changes into HTP (high temperature phase) MnBi at 355℃. On the other hand, the $Sm_2Fe_{17}N_3$ compound is decomposed at the elevated temperature, which makes it difficult to develop sintering processes. In this study, MnBi/$Sm_2Fe_{17}N_3$ hybrid magnets were fabricated to utilize the complementary relation in terms of magnetic properties and sintering processes.

In order to fabricate LTP MnBi ribbons, a single-roller melt-spinning method has been used and subsequent annealing carried out. $Sm_2Fe_{17}N_3$ powders were synthesized by reduction-diffusion and nitrogenation process[2]. These MnBi and $Sm_2Fe_{17}N_3$ powders were mixed in proper weight ratios using surfactant assisted ball milling process. These mixed MnBi/$Sm_2Fe_{17}N_3$ powders were aligned under an applied field of 16 kOe and then compacted with a pressure of 300 MPa for 3 min at 260 ℃.

The microstructure of synthesis ribbons and powders was investigated by a x-ray diffractometer and electron microscopes. The magnetic properties were measured under a maximum applied field of 25 kOe by a vibrating sample magnetometer and the thermal analysis was characterized by a thermogravimetry-differential thermal analyzer.

References

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