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Synthesis nano powder of Sm_2Co_{17}+α-Fe for nanocomposite magnet

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Abstract – Nano powders with a mixture of hard magnetic phase Sm_2Co_{17} and Soft magnetic phase α-Fe were synthesized for nanocomposite magnet in the induction plasma system by controlling various processing parameters. To fabricate narrow particle size distribution, the chamber pressure, plasma power, gas flow rate of nozzle gas and quenching gas were optimized. The particle size and phase structure were characterized by TEM(Fig.1) and XRD(Fig.2). Nano powders of Sm_2Co_{17} + α-Fe were mixed uniformly and had oxygen free surface confirmed by EDS and high resolution TEM.

Nanocomposite mangets have become very attractive, due to many merits such as remanence enhancement and high magnetic energy product[1]. Nanocomposite materials are obtained by controlling the rare earth element content of precursor alloy which are produced in amorphous powders followed by optimized heat treatment. Although those magnetic materials showed Mr/Ms values (≥0.8) higher than the Stoner-Wohlfarth limitation, the obtainable coercivity is still very low, in the range of 2~6kOe[2]. Because the order of formation of hard magnetic phase and soft magnetic phase from amorphous powders is different and the grain growth rate during separation is not the same, the effective exchange coupling between hard and soft magnetic phase has not been guaranteed yet. In this study, we aim to develop a new synthesis method of nanocomposite magnet and characterize their properties.

Nano powders with mixture of hard phase Sm_2Co_{17} and soft magnetic phase α-Fe were synthesized for nanocomposite magnet in the induction plasma system. The induction plasma powder synthesis was performed at low pressure (10~14psi), 35~60kW of power, under a flow of 20~40 l/min of argon gas as a central gas, 80~120 l/min of argon gas and 10~40 l/min of hydrogen gas as sheath gas and 30 l/min of argon gas as carrier gas. Nano powders were scraped from the powder collect connector to a glove box.

Taking into account the X-ray diffraction patterns of nano powders in Fig. 1, one can see that hard phase hard phase Sm_2Co_{17} and soft magnetic phase α-Fe were simultaneously fabricated by induction plasma system and no any other phase were detected. Fig. 2 shows particle distribution and microstructure of mixture of two phases. We confirmed that the surface of the nano particles were not oxidized using high resolution TEM. The clusters are resolved into individual particles with size ranging from 20 to 100nm, depending on the quenching condition employed. Thus, the induction plasma system can be a good candidate for fabricating nanocomposite magnet. The post annealing methods are under investigation

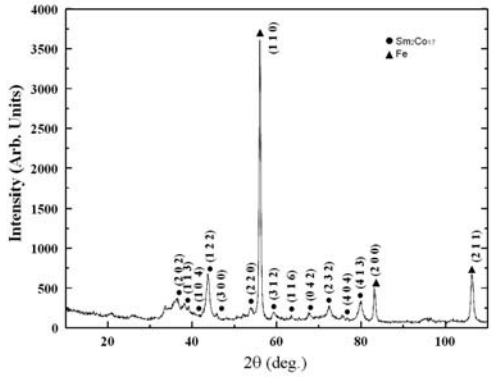

Figure 1: X-ray diffraction pattern of nano powders fabricated in the induction plasma.

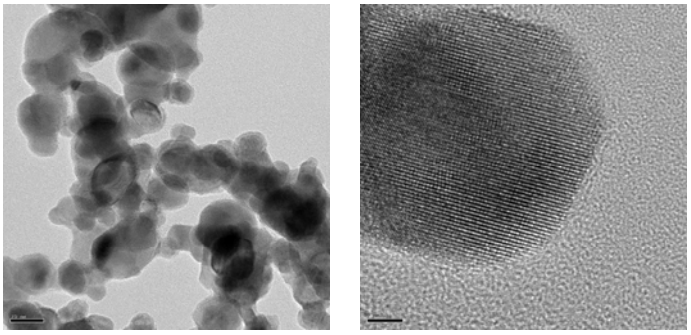

Figure 2: TEM micrographs of plasma synthesized nano powders.

References

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