Fabrication and characterization of ThMn12-type compounds for applications as permanent magnets

Andrés García-Franco
James J. Rosero, Bosco Rodríguez-Crespo, Paula G. Saiz, Jorge Lago, Daniel Salazar

BCMaterials, Bld. Martina Casiano, 3rd. Floor, UPV/EHU Science Park, Barrio Sarriena s/n, 48940 Leioa, Spain

andres.garcia@bcmaterials.net

The growing interest in searching novel magnetic materials for permanent magnet applications is related to the key role they play in the energy efficiency of electrical motors, wind turbines or hard disk drives.

Among others, NdFeB, SmCo5 and similar alloys are the most commonly employed for permanent magnet applications. However, their high content of critical raw materials (CRM), as rare earth elements or Co, motivates the scientific community to explore and find novel eco-friendly materials for that applications. In this context, one of the preferred are the magnetic materials based on the ThMn12-type structure which present a lower amount of CRM and are considered a suitable material to replace the commercial ones due to its high performance.

In this work, three ThMn12-based samples with compositions: $Sm_{1.2}Fe_{11}Si_{0.5}Mo_{0.5}$, $Sm_{1.2}Fe_{11.3}B_{0.2}Mo_{0.5}$ and $Sm_{1.2}Fe_{11.1}B_{0.4}Mo_{0.5}$ were synthesized by arc-melting in order to investigate the effect of the Si and B additives on their properties. Moreover, ribbons of these alloys were fabricated by melt-spinning in order to investigate the extrinsic properties. Magnetic properties of all the samples were evaluated in terms of anisotropy field, Curie temperature, coercive field, remanence and saturation magnetization via VSM, while the crystalline structure was determined by XRD patterns. Elemental mapping and surface topography were also investigated by SEM/EDX and AFM, respectively. This study demonstrates that hard magnetic alloys with the 1:12 structure and Si and B additives are good candidates for permanent magnet applications.

References

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