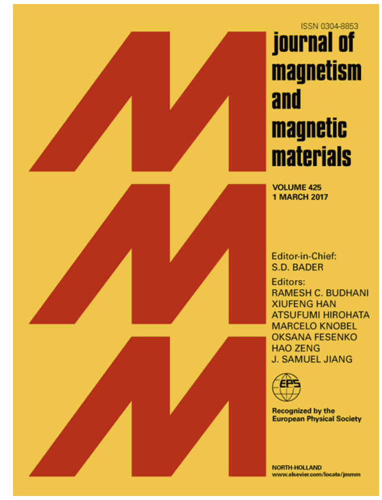

Research articles

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Effect of ball milling process on coercivity of nanocrystalline $SmCo_5$ magnets

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Abstract: In this paper, the effect of ball milling process on remanence and coercivity of nanocrystalline $SmCo_5$ magnets was systematically investigated. Nanocrystalline $SmCo_5$ magnets were prepared by high energy ball milling and spark plasma sintering. And their vast difference of remanence and coercivity were analyzed thoroughly. The anisotropic $SmCo_5$ magnets prepared by wet–milling with surfactant (oleylamine, OY) have high remanence, but the coercivity is much lower than the isotropic magnets prepared by dry–milling. Further analysis indicates the milling process induced changes on the size and shape of grains are the key factors influencing the coercivity. The amorphous powders prepared by dry–milling were crystallized during sintering and the magnets have small and homogeneous grains, while the anisotropic nanoflakes prepared by wet–milling could be well oriented but the magnets have lower coercivity due to the larger and inhomogeneous grains.

Key words: $SmCo_5$ magnets; anisotropic; nanocrystalline; coercivity; ball milling

1. Introduction

With a high Curie temperature (720–920 ℃), large magnetocrystalline anisotropy field (6-30 T), and large energy product (>200kJ·m^{-3}) [1-4], SmCo-based rare earth permanent magnets have exhibited significant potential due to the high-temperature applications [5]. Especially, the preparation of SmCo nanocrystalline magnets have attracted great interest due to the coercivity improvement resulting from a strong pinning effect of grain boundaries on the magnetic domains [6]. Besides, the remanance can be further improved when the anisotropic nanocrystals were orientated [2, 6]. The theoretical maximum energy product of anisotropic magnets is about four times as large as that of isotropic magnets [7].

However, the typical nanocrystalline magnets prepared by melt-spinning or ball-milling, are magnetic isotropic, leading to a large gap between the actual energy product and the theoretical value [2, 8-11]. In order to prepare anisotropic nanocrystalline magnets, the previous research was mainly focused on hot deformed or bonded magnets [12-15]. The main drawbacks of these methods are that the texture degree is not high enough [3]. In recent years, surfactant-assisted high energy ball milling (SAHEBM) has been utilized to prepare anisotropic nanocrystalline magnets. With the help of surfactants, anisotropic nanoflakes can be prepared and orientated easily [12, 16-18]. Followed by spark plasma sintering (SPS), highly textured anisotropic nanocrystalline magnets can be successfully fabricated [3, 19-21]. However, compared with isotropic magnets, the