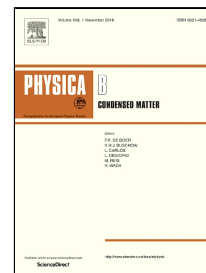


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Effect of Sb substitution on structural and magnetic properties of MnBi based alloys

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Abstract: A series of MnBi_{1-x}Sb_x alloys were prepared by a metallurgical method. The samples MnBi_{1-x}Sb_x were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), differential scanning calorimetry (DSC), vibrating-sample magnetometer (VSM). The effects of Sb substitution on the structural formation, electronic structure and magnetic property of MnBi were investigated experimentally and theoretically. We find that the introduction of Sb atoms may prevent the decomposition of Bi from MnBi, and thus help stabilize the low temperature phase (LTP) MnBi. In addition, first-principle calculations reveal that the saturation magnetization (M_s) and magnetic crystalline anisotropy constant (K) are increased upon increasing Sb-doping concentration, in contrast to a reduction of the Curie temperature (T_C). Therefore, our findings could provide a promising route for enhancing the performance of MnBi permanent magnets.

Key words: decomposition of Bi, MnBi LTP, saturation magnetization (M_s), magnetic crystalline anisotropy constant (K).

1. Introduction

The MnBi based alloy in the ferromagnetic named low-temperature phase (LTP) with the NiAs-type structure possess important characteristics for room-temperature low-cost permanent magnet applications (containing rare-earth-free elements Mn and Bi, moderate spontaneous magnetization M_s but high magneto-crystalline anisotropy K_a) and especially for high-temperature application caused by the positive thermal coefficient of coercivity d_iH_c/dT [1-3]. Generally, in order to prepare high-performance permanent magnets, the green magnetic powder must have a large and balanced values of both M_s and H_c . Some methods were used to prepare high coercive MnBi green powders such as the mechanochemical synthesis method [4], direct chemical synthesis of MnBi particles [5], but these methods has been accompanied by lowering the initial value of M_s of ~ 68 emu/g down to ~ 20 emu/g. This problem of the metastability of LTP causes a quite difficulty in producing high-performance of MnBi bulk magnets with LTP as a single-phase material [6]. The ball-milling process [7-9], which is necessary to enhance the coercivity, usually causes the decomposition of Bi from MnBi LTP. As a result, M_s of the green powders significantly reduces. An effective approach to prevent the mentioned decomposition

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