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Effects of volume and compression on magnetic properties and homogeneity of MnBi prepared by liquid-phase sintering

The formation of low-temperature phase manganese bismuth (LTP-MnBi) prepared by liquid phase sintering (LPS) can be achieved through the diffusion of liquid Bi into Mn. It is known that the LPS process can produce the solid-liquid separation induced by gravitation which easily results in the non-uniform sintered MnBi particles. In this work, we aim to reduce such inhomogeneity by two processes; reducing the volume and applying compression, in order to reduce the gravitational effect. Here, 1 g of Mn and Bi mixture with 1:1 atomic ratio which is 5 times less than normal operation was used. The mixture was then sintered at 325°C for 24, 48 and 96 hours and cooled down naturally to obtain the MnBi. The XRD results showed that the more sintering time, the MnBi concentration increases which could be described by the diffusion process. A vibrating sample magnetometer was used to measure the magnetic characteristics of the sintered samples. The average energy product ((BH)max) values were 1.81, 2.31, and 3.28 MGOe, respectively, consistent with their phase identifications. The compressed samples with packing density of around 8.61 g/cm3 were sintered at 325°C between 3 - 96 hours. It was found that the MnBi phase is significantly low in the samples prepared at 3 - 36 hours compared to the samples prepared at 48 and 96 hours. This resulted in an average (BH)max of 0.37 MGOe for 24 hours-sintered samples while those of 2.87, and 2.42 MGOe were observed in the samples sintered at 48 and 96 hours, respectively. It is noted that the MnBi purity and magnetic properties of the reduced volume samples are higher and more homogeneous while the compressed samples are worse compared to the regularly sintered MnBi. The homogeneity enhancement could be ascribed by the reduction of gravitational effect during liquid-phase sintering. The reduction of magnetic performance and MnBi concentration in the compressed samples could be caused by the limited spaces and pores that hinder the Bi flow and diffusion during LPS process.

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