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Influence of glycerin addition on formation and magnetic properties of MnBi prepared by vacuum sintering technique

This work presents an alternative method to reduce the Mn particle size by adding glycerine during the ball-milling process. This glycerin addition is expected to prevent particle agglomeration to achieve the small and non-gathered Mn particles. The Mn and Bi precursors were fixed at an atomic ratio of 1:1 using Mn particles which were ball-milled in glycerin between 1 and 6 hr. It is seen that the average particle size decreases from 35-40 μm to 15-20 μm after 1 and 6 hr grinding time, respectively. The low-temperature phase MnBi (LTP-MnBi) was prepared by vacuum sintering technique using a sintering temperature of 275 ˆoC for 12 hours under an ultra-high vacuum (≈10ˆ-8 mbar). The sintered LTP-MnBi samples prepared from 1 (MnG_1Bi), 3 (MnG_3Bi), and 6 hr (MnG_6Bi) glycerine-added Mn grinding time were studied by X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photoemission spectroscopy (XPS) and vibrating sample magnetometry. The coercivity values (H_c) are 3.95, 2.35, and 0.95 kOe for MnG_1Bi, MnG_3Bi, and MnG_6Bi samples, respectively. The saturation magnetization (M_s) of MnG_1Bi and MnG_3Bi are relatively similar (˜0.18 emu/g), while the M_s of MnG_6Bi is much higher than those. The XRD result shows that there are a few percentages of MnBi concentration in all samples, implying that glycerin addition could hinder the MnBi formation. This could be explained by the interruption of the diffusion mechanism during liquid-phase sintering due to the coverage of hydrocarbon (i.e., NH_2-CH_2-COOH) groups on Mn particles. Moreover, from elemental composition analysis, it was found that the MnO content tends to increase on the Mn surfaces as the grinding time increases.

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