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Effect of Mn grinding time on structural, chemical and magnetic properties of the Manganese Bismuth prepared by sintering in vacuum

This report presents the changes of structural, chemical and magnetic properties of the low-temperature phase manganese bismuth (LTP-MnBi) magnetic materials as a function of Mn grinding time. The grinding was conducted on the Mn powder with original average size of more than 400 ⊠m using the ball-milling technique. The grinding time was set to be 1-15 hr to obtain different Mn particle sizes prior to the MnBi synthesis. LTP-MnBi powder was successfully prepared by vacuum sintering method which was carried out at 275 oC for 12 hours at pressure below 5 ⊠ 10-7 mbar. Morphology, elemental composition and structure of MnBi powder were investigated by scanning electron microscopy combined with energy dispersive spectroscopy, X-ray photoemission spectroscopy and X-ray diffraction. The magnetic properties were examined using vibrating sample magnetometer. From XRD results, the MnBi content of up to 87.1% was observed with the increment of several oxides from 2.4 wt.% to 3.7wt.% as grinding time increases. This is supported by the XPS results which demonstrate the increment of MnO content on the surface as a function of Mn grinding time. It is seen that the shape of Mn particles is rather similar in all grinding conditions consisting of small and big circular shapes. We found that the average particle size decreases from 30-40 μm to 5-6 μm at 1-15 hr grinding time, respectively. The energy product of 1.59-1.98 MGOe was obtained in the MnBi samples prepared with different Mn grinding time. The saturation magnetization (Ms) decreases from 53.42 to 44.32 emu/g by increasing the Mn grinding time. The unexpected decrease of Ms which strongly results to the decrease of magnetic performance might be explained by the increase of oxides. Oxides on Mn particles could prevent the diffusion of liquid Bi to form the MnBi during sintering.

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