

Mechanical alloying of Co-Si-B based amorphous magnetic alloys

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ABSTRACT

Mechanical alloying (MA) is potentially useful in the processing of amorphous soft magnetic alloys. MA of multi-component amorphous $\text{Co}_{65}\text{Si}_{15}\text{B}_{14}\text{Fe}_4\text{Ni}_2$ alloy from elemental powders was investigated in this work. The as milled powders were characterized using SEM, XRD, DSC and VSM. The alloying process was rapid. XRD and DSC results indicated an amorphous phase formation after the milling of the elemental powders. Amorphization occurred directly from the reaction at the interface of metal and metalloid elemental powders. Dynamic heating induced crystallization events at temperatures of 657°C, 537°C, 524°C and 511°C for the 150 min, 20 h, 40 h and 80 h milled powders respectively. The early formed amorphous phase was inferred to be boron rich from its high crystallization temperature. The saturation magnetization of the as milled powders decreased continuously with increase of milling time, indicating a continuous transformation process. The large stress in the 150 min as milled powders led to a peak of coercivity in the H_c v/s milling time curve. Due to the heterogeneous crystallization induced by mechanical milling, further high energy milling after 20 h was not suitable to prepare homogenous amorphous phase. Annealing of the as milled powders cause deterioration of the soft magnetic properties due to the crystallization, except for the 350°C and 400°C annealing of 20 h milled powders. The properties of the MA amorphous $\text{Co}_{65}\text{Si}_{15}\text{B}_{14}\text{Fe}_4\text{Ni}_2$ alloy were comparable to those of melt-spun amorphous alloy.

Keywords: mechanical alloying, amorphous magnetic alloy, Co based alloy, crystallization, magnetic properties.