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THERMAL STABILITY AND MAGNETIC PROPERTIES OF $\text{Ho}_x\text{Co}_{70-x}\text{B}_{30}$ AMORPHOUS RIBBONS

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Abstract. Properties of the $\text{Ho}_x\text{Co}_{70-x}\text{B}_{30}$, $0 \leq x \leq 8$ amorphous ribbons are investigated. The Curie temperature decreases and the crystallization temperature increases with increasing Ho content. Taking into account the saturation magnetization dependence on holmium content and the positive magnetoresistance one can assume that the magnetic ordering is sperimagnetic.

1. Introduction

In previous papers we examined the influence of the partial replacement of Fe by Tb, Sm or Pr [1, 2, 3] on the properties of Fe-B amorphous alloys. In this study we present the properties of $\text{Ho}_x\text{Co}_{70-x}\text{B}_{30}$ amorphous alloys.

2. Experimental

Amorphous alloys of $\text{Ho}_x\text{Co}_{70-x}\text{B}_{30}$ were prepared over the range $0 \leq x \leq 8$. Ho-Co-B ternary alloys were obtained by melting appropriate amounts of the high-purity constituents in a high-frequency induction furnace in a cold crucible to a homogeneous button in an argon atmosphere. The molten alloy was then rapidly quenched using a Cu disk. Argon ejection pressure of 5-7 kPa and a substrate surface speed of 41 m/s were employed. The gap width of the quartz crucible was 270 pm. The ribbons were 30-40 μm thick and approximately 2 mm wide.

The amorphous nature of the samples was established by X-ray diffraction using CoKα radiation.

The Curie temperatures were determined using a magnetic balance from the curves of squared magnetization, $\sigma^2$, vs. temperature, $T$.

Differential thermal analysis (DTA) at a heating rate of 11 K/min was employed to study the crystallization of the ribbons.

The initial susceptibility was measured in an alternating field of 0.4 Oe at 15 kHz using a bridge of mutual inductance of Hartshorn type.

The measurements of the transverse magnetoresistance in constant magnetic field up to 1.6 T were performed by means of a conventional four-point dc technique with an accuracy of $1 \times 10^{-5}$. The magnetic field was in the plane of the ribbon.

3. Results and discussion

Figure 1 shows some DTA traces for as-quenched alloys. The ribbons display one major exothermic peak temperature which is interpreted as crystallization temperature, $T_c$.

The crystallization and Curie temperatures as function of Ho content are shown in figure 2. It is interesting that a small addition (2 atom %) of Ho to Co$_7$B$_{30}$ caused a considerable jump of $T_c$ from 432 °C to 608 °C.

The effect of the Ho additions on crystallization temperature is related to their influence on the viscosity.
of the Co-B alloy. The larger the addition atom, the greater the increase in viscosity and, consequently, the higher the crystallization temperature [4].

In the alloys under investigation one can distinguish between holmium and cobalt subnets. The Curie temperature is determined mainly by the exchange interactions within the cobalt subnet.

Holmium additions weaken the exchange interactions in the cobalt subnet. This results in decreasing of the Curie temperature (Fig. 2). This reduction of the exchange interactions is also evident from the fact that the saturation magnetization of the Ho$_8$Co$_{62}$B$_{30}$ alloy is lower than that of the Ho$_2$Co$_{68}$B$_{30}$ alloy.

Fukamichi et al. have prepared Co$_{70}$B$_{30}$ amorphous ribbons by the roller quenching and the centrifugal solidification techniques [5]. The Curie and crystallization temperatures of these ribbons amount to 320 °C and 410 °C, respectively.

In case of the Sm$_x$Fe$_{80-x}$B$_{30}$ amorphous alloys the Curie temperature decreases about 15 °C per one Sm atom and the crystallization temperature increases about 23 °C per one Sm atom [2].

Temperature dependence of the initial susceptibility is shown in figure 3.

The transverse magnetoresistance in the investigated ribbons is positive (Fig. 4). The saturation magnetization dependence on Ho content and the positive magnetoresistance [6] suggest a sperimagnetic ordering. Sperimagnetic ordering was also found in Dy-Co alloys [7].

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