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PRESSURE EFFECT ON CURIE TEMPERATURE FOR (FeNi)\textsubscript{90}Zr\textsubscript{10} AMORPHOUS ALLOYS

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Abstract. Pressure effect on Curie temperature, $dT_c/ dp$, for amorphous (FeNi)\textsubscript{90}Zr\textsubscript{10} alloys is estimated indirectly from forced volume magnetostriction. The alloys change from magnetically heterogeneous state to homogeneous one in Fe-rich region with increasing Ni, and stay in homogeneous one even in Ni-rich region differently from the results of $dT_c/ dp$ measured directly.

1. Introduction

Magnetic properties for Fe\textsubscript{90}Zr\textsubscript{10} based amorphous alloys have been investigated recently, because they show Invar effect [1]. In this paper, pressure effect on Curie temperature $T_c$, $dT_c/ dp$, for amorphous (Fe\textsubscript{1-x}Ni\textsubscript{x})\textsubscript{90}Zr\textsubscript{10} alloys is estimated indirectly from measurements of forced volume magnetostriction $d\omega_v/ dH$ using the Kornetzki-Kouvel's relation [2], and is compared with the results of $dT_c/ dp$ measured directly [3]. Those measured directly show that absolute values of $dT_c/ dp$ decrease monotonically with increasing Ni. This suggests that according to the Wagner-Wohlfarth’s discussion [4] these amorphous alloys change from homogeneous state to heterogeneous one.

However, it may be thought that the concentration dependence of $dT_c/ dp$ has the extreme value around $x = 0.1$ of Ni, because concentration dependences of magnetic moment $n$ [1] and spontaneous volume magnetostriction $\omega_v(0)$ obtained from the results of thermal expansion [1] have the maximum values around $x = 0.1$ of Ni like as those for amorphous (FeCo)\textsubscript{90}Zr\textsubscript{10} alloys [1]. Therefore, it is expected that amorphous (FeNi)\textsubscript{90}Zr\textsubscript{10} alloys change from heterogeneous state to homogeneous one around $x = 0.1$ of Ni like as amorphous (FeCo)\textsubscript{90}Zr\textsubscript{10} alloys [5] in contrast to the results of $dT_c/ dp$ measured directly [3]. To ensure that, estimating $dT_c/ dp$ for amorphous (FeNi)\textsubscript{90}Zr\textsubscript{10} alloys should be done in the whole range of Ni.

2. Experiments

Specimens prepared by the single-roller quenching technique were amorphous (Fe\textsubscript{1-x}Ni\textsubscript{x})\textsubscript{90}Zr\textsubscript{10} ($0 \leq x \leq 0.9$) and in the form of ribbons 1-2 mm wide. Ribbons 22 mm long were used as samples. Measurements of $d\omega_v/ dH$ were done by the three-terminal capacitance method [6] in fields up to 18 kOe and at temperatures from 4.2 K to $T_c$.

3. Results and discussion

In figure 1, magnetic moment per 3d transition metal $n$, $T_c$ and crystallization temperature $T_{cr}y$ for amorphous (Fe\textsubscript{1-x}Ni\textsubscript{x})\textsubscript{90}Zr\textsubscript{10} alloys are shown as a function of Ni content $x$, together with the results published [3]. Magnetic moment $n$ shows the maximum around $x = 0.1-0.2$. Curie temperatures $T_c$ are below $T_{cr}y$ in the whole range of Ni content. The results of $n$, $T_c$ and $T_{cr}y$ agree well with the results of reference [3].

Fig. 1. - Magnetic moment per 3d transition metal $n$, $T_c$ and $T_{cr}y$ vs. Ni content $x$ for amorphous (Fe\textsubscript{1-x}Ni\textsubscript{x})\textsubscript{90}Zr\textsubscript{10} alloys, together with the results published [3].
In figure 2, temperature dependences of $\frac{d\omega}{dH}$ for amorphous $(\text{Fe}_{1-x}\text{Ni}_x)_{90}\text{Zr}_{10}$ alloys are shown. The values of $\frac{d\omega}{dH}$ decrease with increasing Ni. The sharp peak is seen at $T_c$ in Fe-rich region, but the broad minimum in Ni-rich region. From these results, pressure effects on magnetic moment per gram $\alpha_0$ at 0 K, $d\ln\alpha_0/dp$, and on $T_c$, $dT_c/dp$, can be estimated indirectly using the Kornetzki-Kouvel's relation [2]:

$$
\frac{d\omega}{dH} = -\rho (d\sigma_s/dp)
$$

and $d\omega/dH = \rho\sigma_s [T (d\ln\sigma_s/dT)(d\ln T_c/dp) - d\ln\sigma_0/dp].$

In this paper, only $dT_c/dp$ is described, and $d\ln\alpha_0/dp$ will be done elsewhere.

According to the Wagner-Wohlfarth's discussion [4], $dT_c/dp$ are expressed as $dT_c/dp = -aT_c + bT_c^2$ for magnetically heterogeneous state and as $dT_c/dp = aT_c - b/T_c$ for homogeneous one from Landau-Ginzburg model. The behavior of $dT_c/dp$ estimated indirectly for amorphous $(\text{FeNi})_{90}\text{Zr}_{10}$ alloys shows to change from magnetically heterogeneous state to homogeneous one around $x = 0.1$ of Ni and to stay in homogeneous state even in Ni-rich region. This is contrast to that measured directly which shows to be magnetically homogeneous state in Fe-rich region and to change to heterogeneous one in Ni-rich region [3].

To check the heterogeneity in details, Mössbauer effect is necessary to be applied.

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