Study of relaxation phenomenon and functional properties in some ferromagnetic shape memory alloys

Abstract

We have investigated in the present thesis the effect of replacing Al with Z in $Ni_2Mn_{1.36}Z_{0.64}$ (Z is Sn, Sb and In) class of ferromagnetic shape memory alloy, with the aim of developing a system intermediate to Z and Al based system so that the resultant system had the better functional capabilities.

Samples were prepared using a tri-arc melting furnace. The X-ray diffraction patterns showed that the replacement of Al with Z lead to stabilization of $L2_1$ phase in the system even in higher Al content. All samples showed martensitic transformations and it was further found that the replacement shifted the structural transformation temperature towards room temperature.

The functional properties of the system like magnetocaloric effect, magnetoresistance and property like exchange bias effect was studied and it was found that Al replacement enhances these capabilities. The replacement of Al with Z enhanced the Magnetocaloric effect in the samples. We also showed that the measurement of MCE using indirect method of magnetization measurement agreed with more direct method of calorimetric measurements in our samples.

The dynamics of the low temperature martensitic phase was studied using both ac and dc magnetization measurement technique. It was found that freezing entities were magnetic cluster rather than individual spins and freezing most probably occurred due to progressive blocking of the magnetic clusters. Cluster size showed dependence on the Z atom and its content. The dynamical study with dc magnetization in Sn and Sb based system showed that it had different dynamics above internal exchange bias field. The dynamics was completely different in case if In system.

We have also shown that magnetocaloric effect in the system can be tuned by giving proper secondary heat treatment either at low or high temperature. We have compared the nature of structural transformation, magnetism, magnetocaloric effect and magnetoresistance for the sample with composition of $Ni_2Mn_{1.36}Sn_{0.40}Al_{0.24}$ and $Ni_2Mn_{1.36}Sb_{0.40}Al_{0.24}$ and showed the effect sp element has in Ni-Mn-Z system.

Al replacement thus gives provides not only way to enhance the functional capability but also gives cheaper alternative in place of Z.