Structure, microstructure and magneto-elastic property study on $Co_{40}Ni_{29}Al_{31}$ ferromagnetic shapememory alloy ribbon

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Abstract

Ferromagnetic shapememory Alloys having huge magnetic field and stress-induced strain are suitable materials for sensors and actuators. Ni_2MnGa being the prototype of these materials and because of its brittleness alternative systems CoNiAl/Ga were recently developed. CoNiAl being a ductile material because of its two-phase microstructure and the large range of transformation temperatures. In this line, a ribbon with nominal composition $Co_{40}Ni_{29}Al_{31}$ was prepared using melt-spun technique. The structure and microstructure of the sample was determined using XRD and SEM. The transformation temperatures were determined using four probe method using a cryocooler within the temperature range of 4 K to 350 K. The elastic and magneto-elastic properties were studied using a Vibrating reed method within the temperature 80 K to 300 K. A constant magnetic field of 300 Oe is applied with a coil wound on the cryostat of the vibrating reed setup. As was expected the sample has two phases of microstructure, from the XRD data, a high amount of b phase with a few amount of c phase was found and it was also replicated in SEM photographs. The phase fractions were found by fitting the XRD data with Reitveld refinement. The transformation temperatures of the sample were obtained from the four probe resistivity measurements, and they are T_{Ms} = 133 K, T_{Mf} =83K, T_{As} = 130 K and T_{Af} = 179 K. From the sound velocity and internal friction study without and with the magnetic field interesting results were found. The martensitic and inter-martensitic transformations were suppressed with the application of magnetic field. It was clearly seen in the sound velocity change plots as a function of temperature and the same was replicated in the internal friction plots. Such studies through light on the magneto-elastic coupling-related issues and are quite useful for the application of these materials for the Micro Electro Mechanical Systems at different operating conditions.

Keywords: CoNiAl Ferromagnetic Shapememory Alloys, Melt-spun technique, Magneto-Elastic Coupling, Micro Electro Mechanical Systems, Artificial Intelligence, Sensors and Actuators