Solidification in Field: Effects on Magnetostrictive Alloys

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Introduction

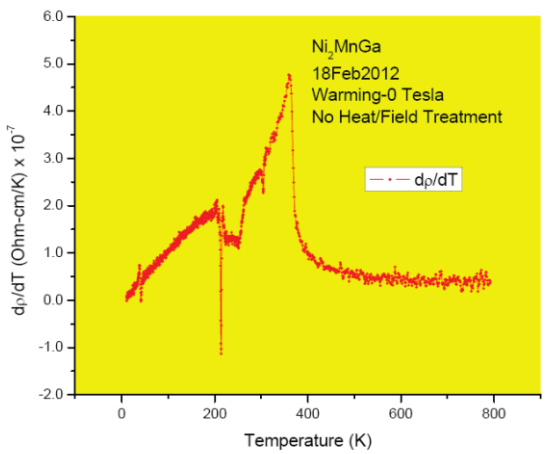
Metallic alloys solidified in magnetic fields of > 30 Tesla should have a large effect on their microstructure and phase transition temperatures when compared to solidification in zero magnetic field. These effects arise from magnetically induced anisotropy and viscosity changes in the melt. Previous studies on magnetic field driven solidification products [1-2] have used only moderate fields of 0.1 - 12.0 tesla and produced significant changes in both microstructure and thermodynamic properties.

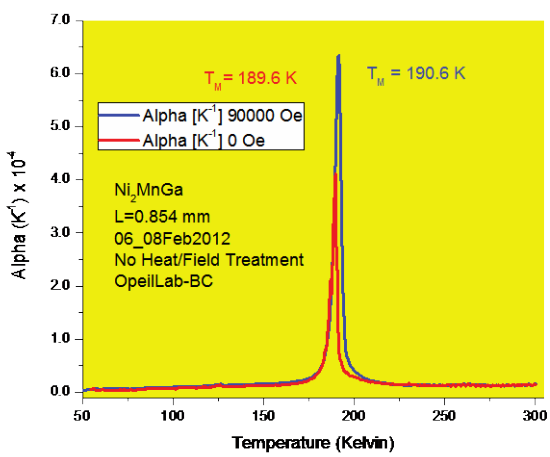
Experimental

Arc-melted polycrystalline samples of Ni_2MnGa and Fe_XGa_Y were placed in the high temperature/high magnetic field furnace where temperatures were raised slowly to ~ 900 ^oC to provide thermal excitation. While the samples were at elevated temperature, the samples were subjected to constant magnetic fields (~31.5 T) in order to promote spin alignment while promoting microstructure and thermodynamic changes. The samples were cooled to ~ 100 ^oC in constant magnetic field then the field was reduced to 0 T. Theses samples were subsequently characterized using a 4-point probe technique with a LakeShore 370 resistance bridge (5-800 K) and with a capacitive dilatometer (5-300K, 0 & 90000 Oe).

Results and Discussion

Our representative data set shown below illustrates the field independent martensitic transition at T_M ~190 K and the ferromagnetic transition at T_C ~ 376 K. Field/heat treated sample data (not shown here) indicate the T_M increased by ~ 20 K (seen in dilatometry) due to application of high field. Further experiments and microstructural analysis are needed to fully determine the impact of magnetic field on this material.





Conclusions

Our data suggests that the martensite phase transition in Ni_2MnGa can be modified by application of heat and high magnetic field.

Acknowledgements

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References:

[1] Wang, Q., *et al.* ISIJ Intl. **50**, 1941 (2010).
[2] Mikelson, A.E., *et al.* J. of Cryst. Growth **52**, 524 (1981).