

Influence of Co on the Curie temperature in Heusler shape memory Ni-Fe-Ga-Co based microwires

R. Varga^{a,*}, O. Milkovic^a, M. Varga^b, T. Ryba^a, M. Vavra^a, O. Heczko^b, L. Heller^b

^a RVmagnetics, Nemcovej 30, 040 01 Kosice, Slovakia

^b IoP CAS, Na Slovance 2, 182 00 Prague, Czechia.

Within the contribution, we present the results on the effect of Co on increasing the Curie temperature in Heusler-based glass-coated microwires. It is shown that 6at. % of Co addition into the Ni-Fe-Ga microwire increases the Curie temperature by 100°C without affecting its transformation temperature.

Keywords: Shape memory, Curie temperature, Heusler microwires.

1. Introduction

For real application, shape memory materials should present large reversible strain, very good mechanical properties, easy production method and should allow for repetitive straining without variation of its mechanical properties. Wire shape introduces additional functionality into the shape memory materials group [1]. Typically, wires show high straining in their axial direction. Moreover, shape anisotropy enhances the magnetic field induced straining.

2. Results and discussion

Heusler-based $\text{Ni}_{55}\text{Fe}_{18}\text{Ga}_{27}$ shape memory microwires produced by Taylor-Ulitovski method show monocrystalline structure along entire wire length that is accompanied with shape memory reversible straining up to 12% without necessity of thermal treatment or training (Fig.1). Since it is possible to control the chemical composition very precisely, the transformation temperature can be easily tuned within 100 – 400 K [2]. Good mechanical properties allow for repetitive structural transition over 1 000 000 times without variation of structural properties.

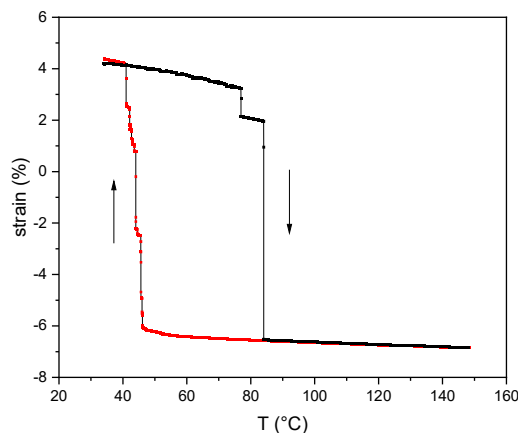


Figure 1: Temperature dependence of strain for $\text{Ni}_{55}\text{Fe}_{18}\text{Ga}_{27}$ microwire.

On the other hand, the Curie temperature of Ni-Fe-Ga based microwire is quite low (20°C), sometimes lower than transformation temperature, which disqualifies them from the possibility to sense the transformation through the permeability change [3].

Within this contribution we show the effect of increasing the Curie temperature of $\text{Ni}_{55-x}\text{Fe}_{18-x}\text{Ga}_{27}\text{Co}_{2x}$ based microwire through the Co alloying. Replacing the Co for Ni and Fe in the way that valence electron concentration is kept constant, leads to the increase of the Curie Temperature, keeping the transformation temperature constant. The biggest increase (100°C) was found for 6 at. % of Co (Fig.2).

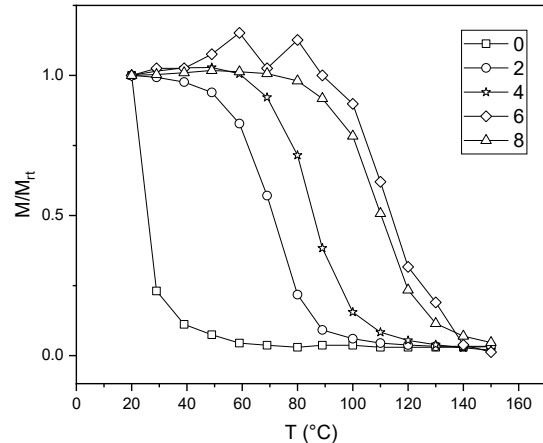


Figure 2: Temperature dependence of reduced magnetization for Ni-Fe-Ga-Co microwires as a function of 0, 2, 4, 6 and 8 at % of Co.

References

- [1] I. J. Alam, C. Bran, H. Chiriac, N. Lupu, T. A. Óvári, L. V. Panina, V. Rodionova, R. Varga, M. Vazquez, A. Zhukov, J. Magn. Magn. Mater., **513** (2020), 167074.
- [2] M. Hennel, M. Varga, L. Frolova, S. Nalevanko, P. Ibarra-Gaytán, R. Vidyasagar, P. Sarkar, A. Dzubinska, L. Galdun, T. Ryba, Z. Vargova, R. Varga, Phys. Status Solidi A, **219** (2022), 2100657.
- [3] L. Frolova, T. Ryba, J. Gamcova, O. Milkovic, P. Diko, V. Kavecansky, J. Kravcak, Z. Vargova, R. Varga, Materials Science and Engineering B, **263** (2021), 114891