Mössbauer and magnetic study of Mn(Fe)NiGe

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Current interest to the half-Heusler alloys based on MnNiGe connected with with the presence of a large number of magnetic phases and phase transitions in this type of materials. These transitions are accompanied by significant magnetocaloric and magnetostrictive effects [1-3].

In the present work, we have investigated the magnetic and Mössbauer properties of $Mn_{1-x}Fe_xNiGe$ solid solutions ($0.05 \le x \le 1.00$) with the purpose to find out the mechanisms of magnetostructural phases formation.

The mixed phase reaction method was used for the polycrystalline $Mn_{1-x}Fe_xNiGe$ synthesis. The mixture of the initial component powders, taken in appropriate weight ratios, was slowly heated to 1323K, annealed for 3 days at 1223K and quenched in ice water. The Mössbauer experiment was performed in usual transmission geometry and a constant acceleration regime. $^{57m}Fe/Rh$ was used as a resonance source, the sample temperatures were ~5K, 77K (liquid nitrogen temperature) and 290K (room temperature).

The Mössbauer data obtained on iron atoms at T=77K do not reveal magnetic interactions on Fe up to the iron content x=0.20. There is no magnetic splitting of the Mössbauer spectra. We suppose that at such iron concentrations Fe atoms enter the sublattice of nickel atoms (trigonal bypiramidal positions MeII), while the deficiency of manganese atoms in the ochtahedral MeI positions is compensated by vacancies. So the magnetic hyperfine interaction of iron atoms in the Me II sublattice is blocked by the local environment of nickel atoms.

All studied $Mn_{1-x}Fe_xNiGe$ $0.05 \le x \le 1.00$ alloys at T=290 K are single-phase solid solutions with a hexagonal structure of the Ni2In type. The analysis of magnetic and Mössbauer data obtained shows that in quaternary solid solutions Mn1-xFexNiGe the iron atoms at concentrations up to x~0.20 preferably replace nickel atoms in Me II structural sites. As iron concentration increases (at x>0.20), the iron atoms replace both the nickel atoms at MeII sites and the manganese atoms at MeI sites..

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