11.1 Debye Temperatures and Magnetic Structures of UFe_xAl_{12-x} ($3.6 < x < 5$) Intermetallic Alloys

by K.Rećko [1], L.Dobrzyński[1),2)], K.Szymański[1)]

Uranium ternary compounds UFe_xAl_{12-x} crystallize in a body-centred tetragonal structure $ThMn_{12}$ (I 4/mmm No.139). The neutron powder diffraction, magnetization measurements as well as Mössbauer investigations clearly indicate the magnetic ordering within the iron sites. The rearrangement of iron magnetic moments from uncompensated antiferromagnetic system in the case of UFe_xAl_{12-x} with $x < 4$, through coexistence of antiferro- and ferromagnetic iron components ($4 \leq x < 5$) to pure ferromagnetic ordering for alloy with $x = 5$ is observed. The study of magnetic structures of aforementioned powder samples by neutrons shows a very rich world of possible uranium - iron magnetic interactions. For all these alloys, the magnetic neutron scattering is generally weak in comparison to the nuclear one and because of the identity of unit cells, there are no pure magnetic reflections. In order to extract magnetic part of the scattering one should thus be particularly careful in taking proper account of the thermal vibration effects. The latter problem is discussed and Debye temperature is calculated using various approaches.

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11.2 Mössbauer and Magnetic Studies of $Fe_{3-x}Co_xAl$

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Mössbauer, magnetic and X-ray diffraction measurements of $Fe_{3-x}Co_xAl$ system were carried out. At small concentration of Co the structure is of DO_3-type. For x=0.5, $Fe_{3-x}Co_xAl$ is located on the ternary Fe-Co-Al phase diagram in the region where two crystallographic phases coexist. It is shown how the presence of Co modifies the lattice parameter and the Debye temperature. Dependence of these two parameters on x is discussed and qualitatively explained as due to the lattice shrinking caused by Co-Al pair interaction. The magnetic moment of Co is estimated to be approximately equal $0.5\mu_B$ at x=0.0 and 1.1 μ_B at x=2.0. The magnetic moment of Fe seems constant and equal to approximately 1.9 μ_B for x<1. It increases to $2.7\mu_B$ at x=2.0. Dependence of the average isomer shift on x and presence of one component only in the spectrum of $FeCo_2Al$ indicate that Co locates preferentially at (A,C) sites which could have been expected basing on earlier data. It is shown that a simple model of the disorder described by the binomial distribution and linear dependence of the hyperfine field of impurity atoms in the nearest neighbourhood is not adequate for description of the observed hyperfine magnetic field distribution.

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11.3 Hyperfine Interaction Study of $(Fe_{1-x}Co_x)_3P$ Compounds

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The magnetic and ordering properties of $(Fe_{1-x}Co_x)_3P$ (x=0, 0.1, 0.2, and 0.33) compounds have been studied by ^{57}Fe Mössbauer technique. These investigations show that Co preferentially substitutes Fe in two out of three metal sites. Variations of the magnetic hyperfine field and the isomer shift with Co content is presented. The fourfold symmetry of each of the metal sites are destroyed magnetically due to different magnetic dipolar contributions and electrically due to different local orientations of the principal axes of the electric field gradient tensor with respect to the easy axis of magnetization. This is explained on the assumption that the magnetic moments lie in the basal-plane.

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