^{57}Fe AND ^{61}Ni MÖSSBAUER EFFECT INVESTIGATIONS OF NICKEL FERRITE-ALUMINATES

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In this paper we report on some new results of ^{57}Fe and ^{61}Ni Mössbauer effect investigations of $NiFe_{2-x}Al_xO_4$ series [1]. Low temperature ^{57}Fe spectra of all investigated samples are interpreted as composed of tetrahedral (A) and octahedral (B) Zeeman patterns. The influence of the random distribution of Al^{3+}, Ni^{2+} and Fe^{3+} ions in the A and B sites on the hyperfine fields corresponding to these sites, manifests itself in the broadening of Zeeman components. At elevated temperatures relaxation processes begin to play an important role. They appear at lower temperatures for highly diluted samples than for weakly diluted ones. The shapes of relaxation spectra indicate that the magnetic type of relaxation process, with only a small contribution of the superparamagnetic process, is involved. Some spectra of each of the investigated samples (Fig. 1) show relaxation features over temperature regions below appropriate Curie temperatures T_c. These regions are narrow for weakly diluted samples and relatively large for highly diluted ones (Fig. 2). In region A static Zeeman patterns are observed. Relaxation spectra are found in region B, while in region C quadrupole doublets are registered. For each of the

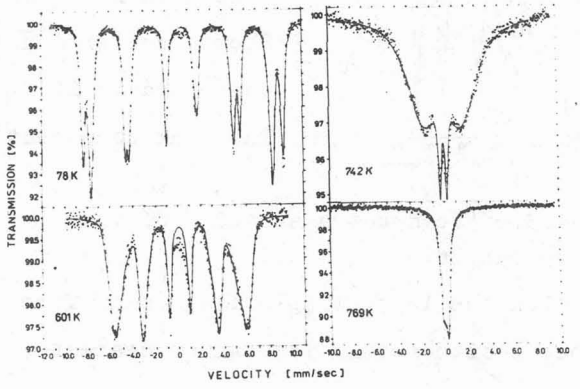
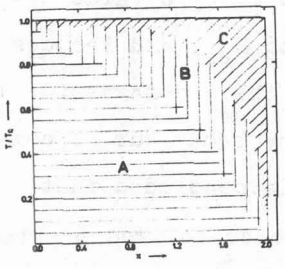


FIG. 1.—Selected ^{57}Fe spectra of the x=0.2 sample.

investigated samples a quadrupole doublet is observed below the magnetometric Curie temperature. This seems to be clear evidence of the influence of the external



magnetic field on the results derived from magnetometric measurements, caused by the stabilization of the

FIG. 2.—The diagram of the types of ^{57}Fe Mössbauer spectra.

relaxation processes. From the spectra of region A, the parameters characterizing the supertransferred hyperfine fields, while from those of region B, the relaxation times, are being studied.

^{57}Fe spectra for the x=1.5 sample were

taken at 4.2 K in 0, 4, 10, 30 and 60 kGs longitudinal external magnetic fields. Some of them are shown in Fig. 3. The spectrum in H_{ext}=0 is decomposed into three components. From the linewidth of the most intense one it is concluded that both A and B Zeeman patterns are contained in it. The weak component

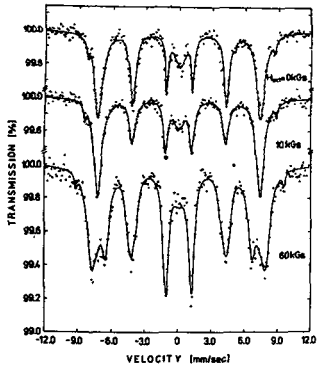


FIG. 3.—^{57}Fe spectra at 4.2 K of the x=1.5 sample.

II with the largest splitting comes from those B-site ferric ions whose nearest--neighbour coordination shell is more rich in Fe and Ni atoms than on the average. The non-resolved component III comes from Fe impurities in the berylium sample holder. The external magnetic field splits component I into two parts, increases the splitting of component II by a value directly corresponding to H_{ext} and induces a Zeeman splitting of the non-magnetic component III. From the behaviour of component II in H_{ext} it is concluded that this component corresponds to iron B sites in which Fe magnetic moments are collinearly ordered and aligned antiparallel to the H_{ext} vector. The intensity of Δm=0 lines of the component I at first decreases with the increase in H_{ext} and then increases for still higher H_{ext}. This may be explained by the influence of H_{ext} on the ordering of the A and B sublattice magnetization vectors, similarly as is observed for antiferromagnets [2], since the x=1.5 composition is very near the compensation point composition [1]. Similar phenomenon was observed earlier for another spinel [3].

^{61}Ni Mössbauer spectra taken at 4.2 K in H_{ext}=60 kGs for samples up to x=1.25 (Fig. 3) are interpreted as being due to Ni ions occupying only the B sites, with a negative hyperfine field. For x=1.5 and 1.9 samples Ni ions are found both in the A and B positions. From the spectra of the x=1.9 sample in H_{ext}=0 and 60 kGs it is found that

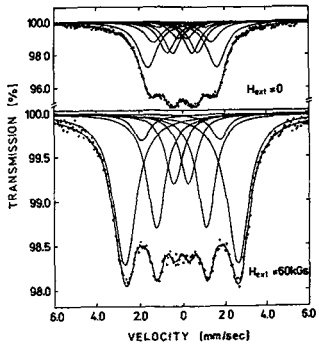


FIG. 4.—^{61}Ni spectra at 4.2 K of the x=1.25 sample.

the signs of hyperfine fields at the A and B sites are both negative.

A more detailed analysis with the new results included will be published elsewhere.

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References

[1] BARA J. J., PĘDZIWIATR A. T., STADNIK Z. M., SZYTUŁA A., TODOROVIĆ J., TOMKOWICZ Z. and ZAREK W., Phys. Stat. Sol. (a) 44 (1977) 325.

[2] FRANKEL R. P., Mössbauer Effect Methodology, Vol. 9, p. 151, (Plenum Press) 1974.

[3] PIEKOSZEWSKI J., KONWICKI A., SUWALSKI J., KISYŃSKA K., MIRACKA A. and MAKOLAGWA S., Proc. Int. Conf. on Mössbauer Spectr., Bucharest, 1977, Vol. 1, p. 163.