MAGNETIC FIELD DEPENDENCE OF THE 57Fe HYPERFINE INTERACTION IN Y(Fe0.1Co0.9)2 AND (Ho0.1Y0.9) (Fe0.1Co0.9)2

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MAGNETIC FIELD DEPENDENCE OF THE $^{57}$Fe HYPERFINE INTERACTION IN $Y(Fe_{0.1}Co_{0.9})_2$ AND $(Ho_{0.1}Y_{0.9})(Fe_{0.1}Co_{0.9})_2$

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Starting with $YCo_2$ a critical Fe and Ho concentration ($>10\%$) was obtained for the appearance of long-range magnetic order /1,2/. Mictomagnetism has to be concluded from bulk magnetic and neutron depolarization measurements for both samples. Therefore Mössbauer measurements without and with applied fields up to 1.72 T have been performed in the temperature range 5 to 300 K.

The temperature $T_M$ (determined by the maximum in the temperature dependence of the magnetization measured in low fields, if the samples are cooled to 4.2 K without an applied field $H_A$) and the temperature $T_A$ (determined by the vanishing of the magnetic hyperfine splitting) coincides for $Y(Fe_{0.1}Co_{0.9})_2$, whereas $T_M < T_A$ is obtained for the Ho containing sample (fig.1).

For $T > T_A$ a quadrupole splitting of 0.44 mm/s (independent of the measuring temperature) is observed for both compounds, in good agreement with the value determined for $YFe_2$ above the Curie temperature ($T_C$) /3/. Since also for the line-width a value of 0.24 mm/s was obtained, the influence of the varying Fe content on the electrostatic interaction in $Y(Fe,Co)_2$ is negligible. For both compounds the values of the isomer shift ($-0.29$ mm/s at 300 K relative to $^{57}$Co in Fe) and the quadrupole splitting are independent of both the different Fe environments and the Ho content. Reinvestigation of $Y(Fe_{0.1}Co_{0.9})_2$ leads to the conclusion that the quadrupole split spectrum exhibiting a relative intensity of $\sim 10\%$ and a different isomer shift /2/ is due to a small

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amount of Fe in the window of the proportional counter. Taking into account that magnetic and quadrupole interactions are comparable, the effective hyperfine field \( H_{\text{eff}} = H_{\text{i}} - H_{A} \) \( (H_{i} \text{ induced field}) \) was determined. \( H_{\text{eff}} \) is the same for both samples (fig.2), indicating that all Fe atoms possess a magnetic moment and that the amount of substituted Ho is only of minor importance for the value of the Fe moment in the paramagnetic state. No distinction for Fe atoms with different environments and therefore no decision as to different moments for Fe was possible. Due to the low ratio \( H_{N}/T \) the saturation hyperfine field could not be determined.

Magnetically split spectra exhibiting a large hyperfine field distribution are recorded at \( T < T_{A} \) (fig.3). Caused by the Ho substitution the mean hyperfine field at 5 K and \( T_{A} \) as well as \( T_{M} \) increase, whereas the magnetization at 4 K and 6.6 T decreases (fig.1).

It was not possible to analyze these spectra using a binomial distribution taking into account either only the different number of nearest Fe neighbours or nearest as well as next nearest Fe neighbour shells. A polarization of the Co atoms depending on the Fe concentration is indicated by bulk magnetic measurements. In connection with the different Fe environments these polarized Co atoms may lead to the observed hyperfine field distribution. For the spectrum which exhibits the strong increase of the quadrupole splitting with decreasing temperature /2/ in the present analysis a small hyperfine field is obtained by taking into account that magnetic and electrostatic interactions are comparable. Magnetically split spectra are reported for 2.2% Fe content /4,5/, which reflects the existence of Fe moments even at low Fe concentrations.

From bulk magnetic measurements the lack of a \( T_{C} \) value, irreversible magnetization processes and magnetic history effects as well as displaced hysteresis loops are obtained. No change of the overall shape of the spectrum measured in 1.72 T compared to that measured without an applied field was observed for both compounds at 5 K. The results confirm the assumption of spin-glass and/or micromagnetic behaviour.

\[ /2/ \text{H. Ortbauer, W. Steiner, R. Haferl Phys. Stat. Sol.} \]
\[ (a) 39 (1977) 157} \]
\[ /3/ \text{M. Morariu, E. Burzo, D. Barb Proc. Int. Conf. Magnetism} (1973) Tom IV, 491} \]