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MÖSSBAUER STUDIES OF THE SUPERSTRUCTURE Fe–Ni 50–50 IN THE SANTA CATHARINA METEORITE AT HIGH MAGNETIC FIELDS

J. Danon, R. Scorzelli and I. Souza Azevedo
Centro Brasileiro de Pesquisas Físicas

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Mössbauer effect; microprobe studies[1,2] and X-ray diffraction[3] have shown that the bulk of the Ni rich (≃35%) Santa Catharina ataxite consists mainly of the 50-50 Fe-Ni superstructure L-10.

We have studied by Mössbauer spectroscopy the behaviour of the ordered phase under high magnetic fields. Using an Oxford superconducting magnet we have measured the Mössbauer absorption spectra of a polished thin slice of the Santa Catharina meteorite up to 50 kOe. The spectra were recorded with a 50 mC source ^{57}Co in Rh matrix at room temperature, the absorber being at 4.2K. The same equipment and fitting procedures described in previous publications[1,2] were employed in the present work.

In the absence of magnetic field the Mössbauer spectrum of the meteorite consists in: (1) a central line assumed to arise from a paramagnetic phase and (2) an asymmetric six line spectrum, due to the L-10 superstructure, which gives rise to a quadrupole splitting caused by the non-cubic surroundings of the iron atoms in this alloy.

This spectrum is similar to that obtained at room temperature and it is nearly the same observed with thin lamellae of Cape York and Toluca octahedrites[4,5,6].

According to microprobe measurements, the paramagnetic central line is assigned to an iron rich phase with about 70% Fe 30 Ni. It is surprising that with this composition this alloy is not ferromagnetically ordered at 4.2K, and details on this result will be described in other publication.

In the presence of applied magnetic fields the $\Delta m=0$ lines decreases in intensity, as is expected from the orientation of the moments in the direction of the field which is parallel to that of the gamma radiation. Quitte abruptly, at 15 kOe practically all $\Delta m=0$ inner lines are supressed. At fields higher than 15 kOe a new magnetic hyperfine spectrum appears, with a smaller magnetic interaction. The hyperfine parameters obtained at 40 kOe for the original spectrum I and the new spectrum II are listed in Table I.

	IS Isomer Shift mm/s	L linewidth mm/s	H_i internal field kOe	Area ratio Spec. I Spec.II
Spectrum I	0.56	0.55	299	
Spectrum II	0.41	0.50	266	1:0.40

The linewidth of the paramagnetic central line of the spectrum increases with the applied field. At 50 kOe an unresolved hyperfine structure is observed; the distance between the two internal lines yields an hyperfine field of the same order of magnitude of the applied magnetic field. This behaviour is typical of a paramagnetic system in an external magnetic field.

In order to interpret the Mössbauer spectrum of the meteorite at higher magnetic field it is important to observe that the same behaviour has been observed with the artificially produced ordered phase in Fe-Ni alloys, obtained by strong electron irradiation[7].

The ordered phase of the Fe-Ni 50-50 alloy shows a very strong magnetic anisotropy, with the characteristics of a uniaxial substance. The quaternary crystal axis is the symmetry axis of the electric field gradient. With respect to this axis the magnetization occurs either in the parallel direction ($\theta=0$) or in the perpendicular direction ($\theta=\frac{\pi}{2}$).

The presence at high applied magnetic fields of two magnetic hyperfine patterns in the Mössbauer spectrum of the ordered phase, both of the meteorite and of the artificially produced alloy Fe-Ni 50-50, is attributed to the two different orientations of this phase in the external field. The difference between the internal fields is due to the anisotropic magnetic contribution term which is given by the expression $K(1-3\cos^2\theta)$. The value of K was calculated to be about -13 kOe [9]. On going from $\theta = 0$ to $\theta = \frac{\pi}{2}$, the anisotropic term will give rise to a difference of about 2K = -26 kOe at room temperature which compares with the observed difference of $\sim$33 kOe observed at 4.2K.

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