MAGNETOACOUSTIC EMISSION AND THERMOMAGNETIC ANALYSIS OF IRON METEORITES AND Fe(Ni) ALLOY

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Introduction: Chemical composition, structure and magnetic features of meteorites are related to conditions of their formation and evolution history. The way of exploring the magnetic properties of the meteorites the thermomagnetic analysis and the analysis of magnetoacoustic emission signal of the samples were chosen. It is known that analysis of iron alloys defectiveness can be successfully carried out on the basis of magnetic behavior investigation using magnetoacoustic emission (MAE). At the same time, Curie temperature is not sensitive to structural characteristic and just only depend on composition of ferromagnetic material. The aim of the work is to determine the nature of the peaks of magnetoacoustic emission in meteorites.

Experimental: In this paper we studied the thermomagnetic and MAE analysis of meteorite samples and their artificial analogue: fragments Sikhote-Alin IIAB, Muonionalusta IVA and Campo del Cielo IAB-MG iron meteorites, Seymchan PMG and manufactured alloy (Fe – 5,26%Ni – 0,74%Co). Measurements were performed on a measuring system, which is described in the references [1, 2]. Among different magnetic characteristic Curie temperature determine by analysis of differential magnetic susceptibility dependence on temperature [1]. The samples were heated from 20 °C to 800°C at a constant rate. To measure the MAE, the samples are magnetized using solenoid with a different frequency of magnetization reversal (0.1 to 0.3 Hz). The received signal carried out on the different frequencies (50 to 150 kHz).

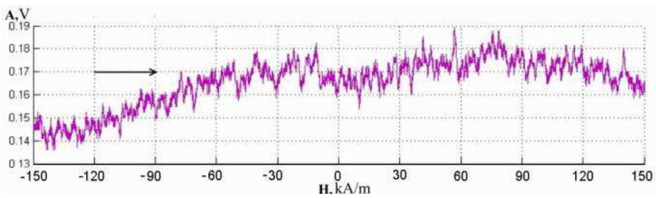

Fig. 1. MAE signal of the meteorite Sikhote-Alin.

Results: MAE curves type for meteorite samples (fig. 1) and Fe(Ni, Co) alloy seem identical: there are two peaks, without the strongly visible peak of the curve which are approximately an equal in magnitude. The first peak is most pronounced in the field range from -37.5 kA/m to 4.5 kA/m and the other from 40 kA/m to 90 kA/m. In the samples of iron meteorites, the curves for the dependence of the differential magnetic susceptibility on temperature are observed smoothly and a sharp decrease at temperatures of about 720-780 °C. This curie temperature is typical for iron meteorite and as a rule explain by $Fe_{\gamma} \rightarrow Fe_{\alpha}$ phase transition. During cooling of some sample of iron meteorite (Campo del Cielo IAB-MG, Seymchan PMG) magnetic susceptibility recover stepwise: first stage take place at a temperature of 755-720 ºC, where magnetic susceptibility increase from 10 to 50 %. And second stage take place at a temperature of 685-580 ºC when magnetic susceptibility become to initial value. The other iron meteorites (Muonionalusta IVA, Sikhote-Alin IIAB) has phase change from paramagnetic condition to ferromagnetic condition at a temperature of 650 – 580 ºC during cooling. Reheating do not influence on the shape of a curve magnetic susceptibility of iron meteorite. Thermomagnetic curve of manufactured alloy Fe – 5,26%Ni – 0,74%Co are similar with meteorite curve like Sikhote-Alin IIAB and Muonionalusta IVA. Temperature of phase transition in alloy from ferromagnetic condition to paramagnetic substance is 780 ºC. Such high value of phase transition temperature conditional to lower nickel content in manufactured alloy.

Conclusion: The thermomagnetic curve of investigate meteorites correspondence with the result of other works about different iron meteorite [3]. The main magnetic mineral in research meteorite is kamacite. Several peaks in the MAE curve are due to the structural characteristics of each individual sample. In the samples of iron meteorites, the smooth course of the thermomagnetic analysis curves and the sharp decrease indicate the presence of a single magnetic phase, which determines the magnetic properties of the samples. Several peaks in the MAE curve are not due to the presence of several magnetic phases. They are caused only by to structural characteristics: intrinsic stresses and lattice defects that are comparable to domain wall sizes [4]. This work was supported by the Act 211 of the Government of the Russian Federation, agreement no. 02.A03.21.0006.

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