Temperature anomalies of the hyperfine magnetic fields on ^{111}Cd probe nuclei in ferro- and antiferromagnetic phases of the ordered FeRh alloys

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FeRh ordered alloy crystallizes in the bcc B2 structure [1], presents first order phase transition from antiferromagnetic (AF) ordering at low temperature to ferromagnetic (F) state above 350 K [2], and shows significant magnetocaloric effect near RT [3]. Recently, FeRh alloy has also been considered as an interesting material for spintronics applications [4].

In the AF state, FeRh has compensated AFII-type magnetic structure with μ_{Fe}=3.3 μ_B and μ_{Rh}=0. In the F state of FeRh both Fe and Rh atoms have magnetic moments of μ_{Fe}=3.2 μ_B and μ_{Rh}=0.9 μ_B, respectively [5]. The Fe – Rh compounds were studied by Mössbauer spectroscopy (MS) on ^{57}Fe [6, 7] and ^{119}Sn probe nuclei [8].

In this work, we have, for the first time, investigated the HFs for ^{111}Cd probe atoms in two FeRh samples of different composition by perturbed γ-γ angular correlation (PAC) spectroscopy in the range from 40 K to a temperature above the T_C. The alloy $Fe_{0.48}Rh_{0.52}$ (A_1 sample) is AF at low temperatures. At the temperature T_t = 345 K the first order phase transition is observed, and this compound becomes F at the temperatures lower than T_C = 685 K. The alloy $Fe_{0.52}Rh_{0.48}$ (A_2 sample) is only ferromagnetic below T_C = 800 K. It was established that in both alloys ^{111}Cd probes substitute only Fe ions.

The HFs values extrapolated to 0 K were found to be $B_1(0)$ =8.70(5) T and $B_2(0)$ =5.53(5) T for AF and F ordering of A_1 and A_2 samples, respectively. The HF in the AF state is almost 60% higher than the HF in the F alloy. The dependences B_1 (T) and B_2 (T) show anomalous behavior. At T_t = 345 K, phase transition AF-F is accompanied by a sharp decrease in the HF at ^{111}Cd probe nuclei. Earlier, an increase of the corresponding HFs was observed for ^{57}Fe atoms and ^{119}Sn impurity atoms in the region of AF-F transition by MS in [6] and [8]. Analysis of B_1(T) and B_2(T) has allowed to obtain the temperature dependences of the competing contributions B_{Fe} (T) and B_{Rh} (T) to the HFs on ^{111}Cd probe nuclei in FeRh alloys.

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