Modeling of thermomagnetic curves obtained with Mössbauer spectrometry for two-phase nanocrystalline alloys

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Thermomagnetic curves for two-phase nanocrystalline alloys have been analyzed theoretically in order to understand the peculiar behavior in vicinity of the phase transition point of the amorphous matrix, evidenced experimentally with Mössbauer spectrometry [1-3]. We propose a simple model of the system composed of two magnetically coupled phases of distinctly different Curie temperatures. The effective exchange integral (say, for the first phase) has been set in the form: $J_1^{\text{eff}} = J_1(1+q_1\langle S_2^z\rangle/S_1)$, where J_1 and S_1 denote the exchange integral and spin number for the uncoupled first phase, $\langle S_2^z\rangle$ signifies the mean value of spin projection in the second phase and q_1 is the coupling coefficient between phases. Numerical calculations in the frame of the mean field approximation (MFA) show a slope jump on the temperature dependence of the mean spin value for the second phase of higher Curie temperature T_{C2} at the Curie point of the first phase T_{C1}. Moreover, we proved an increase of the T_{C1} when the coupling coefficient had a positive value (Fig. 1). The Mössbauer spectrometry provides a separate information about hyperfine fields for amorphous and nanocrystalline phases. Fitting of our theoretical results to the temperature dependences of hyperfine fields in the case of FINEMET [1] reproduces qualitatively the experimental curves (Fig. 2) for q_1 = 0.18. More exact analysis would demand a consideration of the interface phase, existing among the amorphous remainder and nanocrystalline grains.

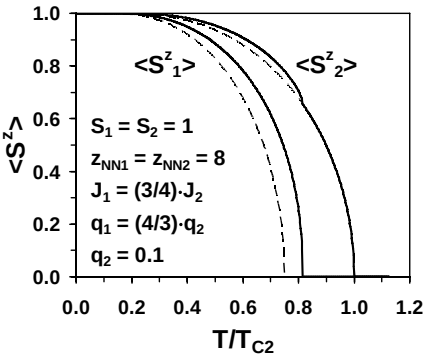

Fig. 1. Temperature evolution of mean spin value – simulation for nanocrystalline and amorphous phases.

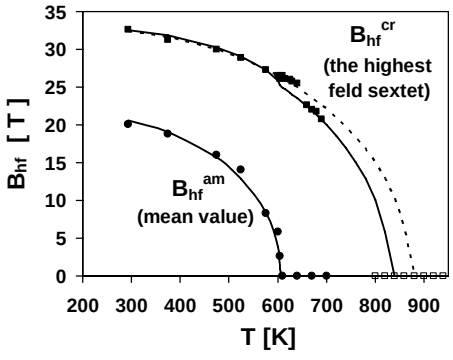

Fig. 2. Fit of hyperfine fields vs. temperature for crystalline and amorphous phase in FINEMET.

[1] K. Brzózka, A. Ślawska-Waniewska, K. Jezuita, M. Gawroński, H.K. Lachowicz, Proceedings of All-Polish Seminar on Mössbauer Spectroscopy OSSM'96, Lublin 13 (1996).
[2] K. Brzózka, A. Ślawska-Waniewska, K. Jezuita, M. Gawroński, J.M. Grenéche, Molecular Physics Reports **22** (1998) 27.
[3] T. Szumiata, B. Górka, A. Zorkovská, P. Sovák, J. Magn. Magn. Mater. **288** (2005) 37.

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