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Investigation of Nanosized Magnetic Materials by SEDM Technique

Magnetic properties of nanostructure materials show the high variety and considerably differ from a massive one [1]. Before 40 years ago the main techniques for studying dynamics processes involved in interaction of nucleus with electron shell have been nuclear magnetic (NMR) and electron spin resonance (ESR). The Mössbauer spectroscopy technique, owing to its high sensitivity to hyperfine interaction between the nucleus and its environment, has greatly extended the range of substances that can be investigated, and in certain cases has become a unique method for studying these phenomena. Most of experiments that used Mössbauer spectroscopy to study various dynamic processes (e.g., diffusion, paramagnetic, spin-spin, spin-lattice relaxation, etc.) were done in the conventional transmission geometry. This technique is simple enough, but, in some applications it leads to difficulties in resolving the contributions from dynamic processes to the total spectrum. For example, in the case of slow relaxation the transmission spectrum is characterized by line broadening only. However, the broadening may be caused also by multiphase effects, unresolved hyperfine electric and magnetic interactions that lead to an ambiguity in spectrum interpretation. These problems may be solved through application of selective excitation double Mössbauer effect (SEDM) technique [2]. The Mössbauer spectrum measured in this case bears information on solid-state processes that occur during the nucleus lifetime: if within this time the nucleus manages to exchange energy with its environment, the energy of the re-emitted gamma-quantum will differ from that of the gamma-quantum exciting the nucleus. The SEDM technique, by its potential possibilities, can be powerful method of investigation of relaxation processes in solids. The method gives the unique possibility to obtain direct evidence for occurrence of relaxation and also to determine qualitative and quantitative characteristics of the processes even in situation where Mössbauer spectra are essentially broadened by other physical reasons.
Capabilities of SEDM technique in the investigation of magnetic properties of small particles are illustrated by the analysis of magnetite nanoparticles (Fe3O4) and aluminosubstituted goethite system Fe(1-x)AlxOOH.

References

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[2] V.G. Semenov, S.M.Irkaev, Yu.N. Malsev. Highly sensitive Mössbauer spectrometer for SEDM and RSMR investigations. NIM B 95, (1995) 253-259

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