

# MÖSSBAUER SPECTROSCOPY WITH HIGH VELOCITY RESOLUTION: NEW POSSIBILITIES OF CHEMICAL ANALYSIS IN MATERIAL SCIENCE AND BIOMEDICAL RESEARCH

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*Abstract* – An improvement of velocity resolution in Mössbauer spectroscopy permitted us to carry out a more detailed study of iron chemical state in various iron-containing compounds in a wide range of research. New possibilities of Mössbauer spectroscopy with high velocity resolution were shown in the studies of meteorites, nanocomposites, pharmaceuticals and biological subjects.

*Keywords* – Mössbauer spectroscopy; high velocity resolution; chemical analysis; material science; biomedical research

## I. INTRODUCTION

Mössbauer spectroscopy is very useful technique for chemical analysis of iron-containing compounds in various subjects. Majority of Mössbauer spectra were measured with registration in 512 channels or less. However, an increase in the velocity resolution of Mössbauer spectroscopy leads to decrease of experimental error in determination of Mössbauer hyperfine parameters and more reliable fit of complicated Mössbauer spectra. Therefore, Mössbauer spectroscopy with high velocity resolution may be useful for comparative study of iron compounds with small variations of iron electronic structure as well as in case of plural-component iron-containing materials.

## II. EXPERIMENTAL

New possibilities of Mössbauer spectroscopy is related to high precision, sensitive and stable spectrometer SM-2201 with the saw-tooth velocity reference signal. Mössbauer spectra were measured in transmission geometry with moving absorber with registration in 4096 channels with further presentation in 1024, 2048 by consequent summation of four or two neighboring channels, respectively, and in 4096 channels. Samples of iron meteorites, ordinary and carbonaceous chondrites, cupric ferrites, pharmaceutical products, iron-containing proteins and tissues were studied by Mössbauer spectroscopy with high velocity resolution.

## III. RESULTS AND DISCUSSION

### A. Meteorites

Mössbauer spectra of iron meteorite Sikhote-Alin and extracted phosphides, iron meteorite Chinga, 11 ordinary chondrites and unique carbonaceous chondrite Isheyevo CH/CB were presented in 1024 channels. Spectrum of

ordinary chondrite is shown in Fig. 1, a. The fitting of complicated spectra permitted us to reveal components which were not revealed in the spectra with low velocity resolution.

### B. Nanocomposites

Mössbauer spectra of  $(\text{CuFe}_2\text{O}_4)_{1-x}(\text{SnO}_2)_x$  ( $x=0, 1, 5, 10$  and 20) nanocomposites presented in 1024 channels demonstrated the presence of additional components which were not revealed in the spectra presented in 512 channels.

### C. Pharmaceutical products

Mössbauer study of iron state in iron-containing vitamins and dietary supplements revealed ferric and ferrous impurities and some main compounds parameters of which did not correspond to those announced by the manufacturer.

### D. Biological samples

Mössbauer spectra of ferritin and its pharmaceutically important model Imferon presented in 2048 channels revealed the clearest differences in hyperfine parameters in comparison with low velocity resolution spectra (Fig. 1, b).

Comparison of Mössbauer hyperfine parameters for human liver ferritin, chicken liver and spleen obtained from spectra presented in 1024 channels demonstrated clear differences in the iron state.

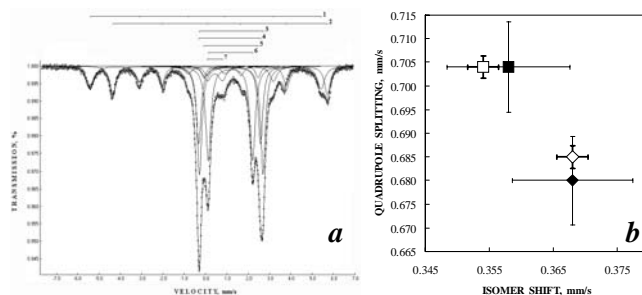


Figure 1. Mössbauer spectrum of Vengerovo H5 presented in 1024 channels (a) and Differences of the hyperfine parameters for Mössbauer spectra of Imferon ( $\square$ ) and ferritin ( $\diamond$ ) presented in 2048 channels in comparison with those presented in 512 channels ( $\blacksquare$  and  $\blacklozenge$ , respectively) (b).

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