

A Study of the Magnetic Filler for Suppositories by Mössbauer Spectroscopy

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Mössbauer spectroscopy methods are discussed when applied to test the properties of magnetic suppositories used in medicine.

The experiments were carried out on magnetic rectal suppositories containing parmadiene and fine-dispersed ferrite powder ($\text{BaO} \cdot n\text{Fe}_2\text{O}_3$) as a magnetic filler. According to the data on the value of effective magnetic field on ^{57}Fe nuclei in ferrite magnetic sublattices, the stoichiometric n -number equals approximately 5.5; this value corresponds to the composition range of optimal magnetic properties.

Introduction

Until recently Mössbauer spectroscopy has not been widely applied to medical problems, such as searching for new approaches to improve the efficiency of drugs. This method, however, appears to be unique for testing the medicinal composites since it allows to receive simultaneously information about both the local peculiarities of the substance being studied and its macroscopic properties.¹⁾

It is also important that, depending on the specific aims of Mössbauer phase analysis (MPA), the methods to extract information from Mössbauer spectra are to be varied widely.²⁾ The goal of this investigation was a study of phase composition of magnetic filler.

Experiment

We have investigated the magnetic rectal suppositories (MRS) containing parmadiene (bis-N-methylcarbamine ester 2,6-bis oxymethyl pyridine).

The suppositories were prepared on the base of cacao-seed oil, vitepsol, alloy of 95% salomas and 5% emulgator No 1, and polyethyleneglycol (5% PEG-400 and 95% PEG-1500). Fine-dispersed powder of barium ferrite $\text{BaO} \cdot n\text{Fe}_2\text{O}_3$ (the size of particles $\sim 1\mu\text{m}$) was used as a filler for MRS; its inclusion allowed controlling the rate of the drug release.

Mössbauer absorption spectra were measured by means of a conventional Mössbauer spectrometer with a 30mCi $^{57}\text{Co}/\text{Cr}$ source at room temperature. Range of investigated doppler velocities is up to 12mm/sec.³⁾ Spectrometer was calibrated using standard absorber and nitroprusside $\text{Na}_2\text{Fe}(\text{CN})_5\text{NO} \cdot 2\text{H}_2\text{O}$.

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Table 1. Model fitting results for the spectrum of the particles $BaO \cdot nFe_2O_3$ in the magnetic suppository

Type of Fe^{3+} -sites	Magnetic moment orientation	Isomer shift δ^a (mm/s)	Magnetic field H_n (kOe)	Quadrupole displacement ϵ (mm/s)
12k	↑	0.62 ₁	414 ₁	0.43 ₁
4f1	↓	0.52 ₁	488 ₁	0.11 ₁
4f2	↓	0.67 ₂	516 ₂	0.18 ₁
2a	↑	0.59 ₂	507 ₃	0.03 ₂
2b	↓	0.53 ₂	403 ₁	2.51 ₂

^a Relative to $Na_2[Fe(CN)_5NO] \cdot 2H_2O$.

Results and Discussion

To obtain the optimal combination of suppository constituents it was necessary to elucidate whether the barium ferrite particles maintain their magnetic properties being introduced in suppository content.

For this purpose we used the data on magnetic hyperfine structure of the Mössbauer line of ^{57}Fe nuclei in the particles of barium ferrite (see Table 1). In accordance with the peculiarities of the Ba-ferrite structure, Fe atoms occupy five nonequivalent, both crystallographically and magnetically, types of sites and, as a result, for a fine enough sample (the absorber thickness $d \leq 0.2mg \text{ } ^{57}Fe/cm^2$) the spectrum of magnetically ordered ferrite particles is a superposition of five partial Zeeman sextets with various intensities (see Fig. 1).⁴⁻⁷ The most intensive among them (it has half of the whole spectrum area) is the most sensitive to the n -number in the structural formula $BaO \cdot nFe_2O_3$ ^[2]. It should be noted that the value of the effective magnetic field H_n on ^{57}Fe nuclei for the sites of the type mentioned (12k in standard notation) decreases due to the break of superexchange bonds with appearance of vacancies in the structure at decreasing n . Comparative analysis of model fitting data for magnetic suppository spectra and those for the initial component ($BaO \cdot nFe_2O_3$) shows high stability of

magnetic properties of the ferrite particles in suppository. The values of partial spectra parameters are in agreement with those known for the barium ferrite^[3] in both cases.

According to the value of H_n for the most intensive partial sextet^[8], the composition of ferrite particles in suppositories appears to be optimal to maintain stoichiometric n -number of approximately 5.5. This n -value, as reported in 9), corresponds to the composition range of barium ferrites with optimal magnetic properties and, consequently, high efficiency of the suppository magnetic component.

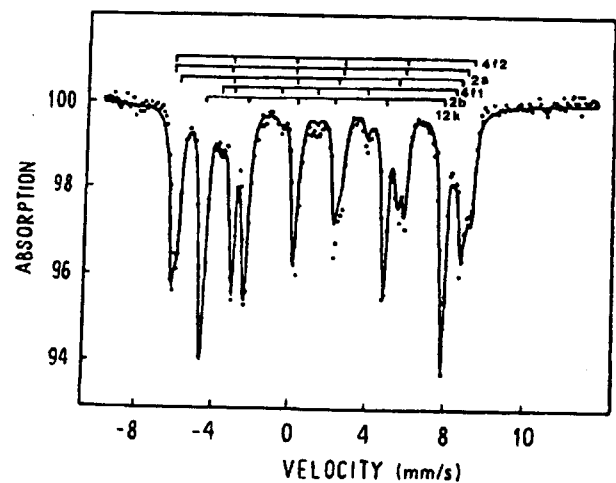


Fig. 1. Mössbauer spectrum ^{57}Fe in the magnetic suppository at 300K and the result of its model fitting (the magnetic component— $BaO \cdot nFe_2O_3$).

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좌약제조를 위해 사용되는 자기물질 충전제에 대한 연구

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피스마우어 분광법을 사용해서 의학에서 사용되는 자기물질을 포함하는 좌약들의 자기적 성질을 시험했다. 이번 실험들은 파르마딘(parmadine)과 자기물질 충전제로서 미세한 입자상태로 분포되어 있는 바륨 페라이트 분말 $\text{BaO} \cdot n\text{Fe}_2\text{O}_3$ 을 포함하고 있는 직장 내에 투여되는 좌약들에 대해 실시되었다.

바륨페라이트에 포함된 ^{57}Fe 동위철 핵으로 인한 유효 자기장값에 따르면 바륨 페라이트 $\text{BaO} \cdot n\text{Fe}_2\text{O}_3$ 의 구조공식 n값은 대략 5.5였다.

이 값은 최적의 자기적 성질을 나타내는 좌약구성 성분비와 일치한다.