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A Study of the Properties of Magnetic Particles in Medicinal Ointments

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ABSTRACT

Stability of the properties of magnetite particles in novel medicinal magnetic ointments of multipurpose application has been studied by M ssbauer spectroscopy. It has been found that the comparative analysis of the results obtained by model fitting of ^{57}Fe nuclei spectra with those known for the system Fe_3O_4-γ-Fe_2O_3 allows to identify the phase composition of the particles.[1)]

It is noted that this composition, as well as that of the initial pure component in the form of a highly dispersed fraction (~100 Å), differs noticeably from the stoichiometric one.

From the magnetic hyperfine field despite small particle sizes, the particles exhibit no superparamagnetism[2)] (in the temperature range from 95 to 300K).

Radiative sterilization of the ointments has no effect on the magnetic component composition.

INTRODUCTION

It is well known that introduction of any novel drugs into wide medical practice required not only their adequate testing but development of the bases for their standardization and quality criteria as well.

The composition of a drug and physicochemical properties of its constituents determine to a large extent the choice of a concrete complex of research methods.[3), 4)] Recently some new ointments for multipurpose application have been composed. Their medicinal effect is improved due to a magnetic component. One of the main problems to be solved in the course of ointments testing for subsequent application is to estimate the properties and composition stability of the magnetic component. This was the aim of our experiment.

EXPERIMENTAL PROCEDURE

We have investigated the vaseline-lanoline-based magnetic wound-healing ointments with highly dispersed magnetic particles synthesized by Elmar's method.[5] Since the magnetic component contains iron (and 30mCi ^{57}Fe-isotope), it appears to be advisable to use M ssbauer spectroscopy, in combination with magnetic measurements, as the main tool for undestructive control in these search investigations, like in.[6] Then, a M ssbauer spectrome ter of the electromechanical type was used in the constant acceleration mode. A ^{57}Co source in a rhodium matrix was used at room temperature.[7] Spectrometer was calibrated using standard absorber sodium nitroprusside $Na_2Fe(CN)_5No\cdot 2H_2O$. For a fine enough samples we prepared the absorber thickness d 0.2mg $^{57}Fe/cm^2$. M ssbauer spectra were taken at various temperatures from liquid nitrogen to room temperature.

RESULTS AND DISCUSSION

The main conclusions about the properties of magnetic particles have been made while searching for the fitting model for the ^{57}Fe nuclei spectra (at temperatures ranging from 95 to 300K). The series of the magnetic ointments samples has been analyzed at different stages of the probable time evolution of their properties. Identification of the phase composition for a ferri-ferrous component of the samples studied has been carried out by means of comparative analysis of the results obtained by model fitting and those reported earlier for spectra parameters of the system Fe_3O_4-γ-Fe_2O_3.

It has been found that for all cases, including the initial pure component in the form of a highly dispersed fraction (~100 Å), the composition of magnetic particles differs noticea bly from the stoichiomeric one (see Table 1). This is also supported by the tendency of changing in partial spectra with temperature (Fig. 1). The deviation from stoichiometry obviously results from oxidation of magnetic particles both in the course of synthesis (proba-bly immediately after it) and during storage.

Table 1. The model fitting parameters of Mössbauer spectra of magnetic particles in medicinal ointments at 95K

시료	Hn(kOe)			ε(mm/s)			δ[a](mm/s)		
	Fe_A^{3+}	Fe_B^{3+}	$Fe_B^{2.5+}$	Fe_A^{3+}	Fe_B^{3+}	$Fe_B^{2.5+}$	Fe_A^{3+}	Fe_B^{3+}	$Fe_B^{2.5+}$
1	494_1	500_1	466_1	0.03_2	0.003_9	0.05_3	0.49_3	0.72_4	0.91_8
2	497_1	498_1	445_3	0.04_1	0.05_1	0.05_2	0.57_2	0.81_5	0.99_7
3	499_1	501_1	458_3	0.03_2	0.08_2	0.12_5	0.56_2	0.76_4	1.13_7
4	495_1	498_1	469_1	0	-0.14_4	0.24_3	0.53_5	0.65_5	0.91_5
5	499_1	502_1	420_7	0.03_4	-0.06_4	0.31_5	0.53_7	0.65_7	0.91_6

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

1-initial component; 2-magnetic paste-concentrate (MPC); 3-MPC with medicinal addition; 4-$Fe_{2.94}O_4$[1], 5-$Fe_{2.86}O_4$[1].

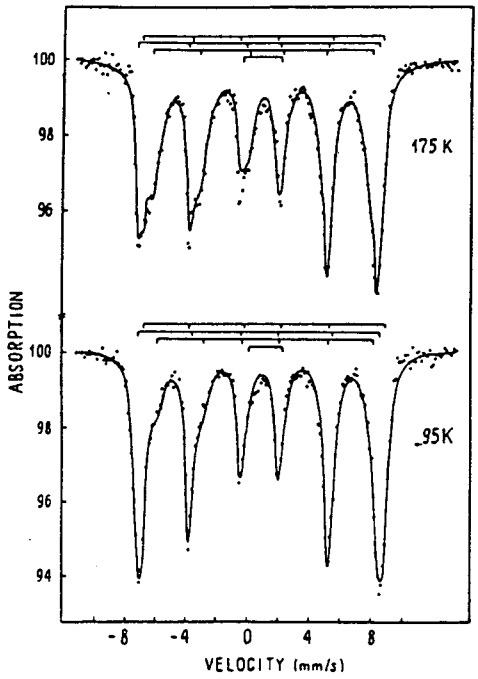

Fig. 1. M ssbauer spectra of 57Fe in the magnetic component particles of the paste-concentrate

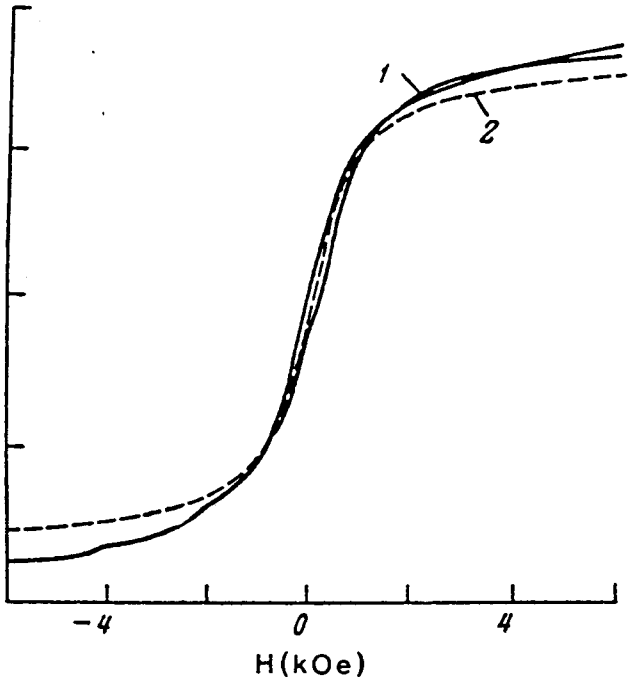

Fig. 2. Magnetization curves of the magnetic component particles in the paste-concentrate

Additional oxidation of the particles results also from their usage as the base for magnetic paste-concentrate. In spite of its small sizes, the particles exhibit practically no superparamagnetism apparently due to their joining into conglomerates (Figs. 1 and 2). As it has been shown by M ssbauer phase analysis, radiation sterilization of the ointments has no effect on the composition of the magnetic component.

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의학용 연고제에 포함된 자성물질 입자들의 성질에 대한 연구

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초 록

뫼스바우어 분광법을 사용해서 다목적용으로 제조된 의학용 치료 연고제내에 포함된 자성물질 입자들의 성질들이 연고제내에서 안정되게 존재하고 있는 지를 연구하였다.

자성물질 내에 들어있는 ^{57}Fe 동위철 핵자들에 의해 나타나는 뫼스바우어 스펙트럼에 대해 분석한 결과들과 Fe_3O_4-γ-Fe_2O_3 체계[1]에 대해 잘 알려진 분석결과들을 비교 연구하여 자성입자들의 구성상태를 규명할 수 있었다.

결과적으로 나타난 연고제내에 자성물질의 합성상태는 합성되지 않은 순수한 자성물질만의 성분 분석과는 다른 결과를 나타내었다. 한편, 자성물질 입자의 크기(~100 Å)가 매우 작음에도 불구하고 이들 입자들은 95K~300K 범위에서 초 상자성 형태의[2] 뫼스바우어 스펙트럼 특성을 나타내지 않았다. 또한, 연고제를 방사성 살균한 후에도 자성물질 성분 구성에는 변화가 없었다.