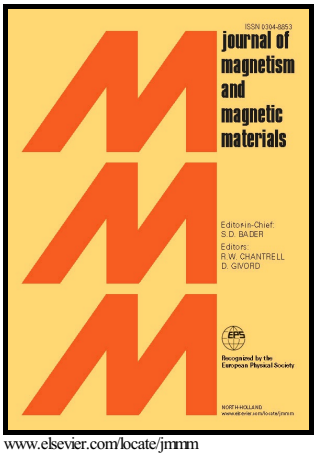

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PII: S0304-8853(16)32439-8
DOI: http://dx.doi.org/10.1016/j.jmmm.2016.10.002
Reference: MAGMA61914

To appear in: *Journal of Magnetism and Magnetic Materials*

Received date: 15 July 2016
Revised date: 30 September 2016
Accepted date: 1 October 2016

Cite this article as: E.K. Nepomnyashchaya, A.V. Prokofiev, E.N. Velichko, I.V. Pleshakov and Yu I. Kuzmin, Investigation of magneto-optical properties o ferrofluids by laser light scattering techniques, *Journal of Magnetism an Magnetic Materials,* http://dx.doi.org/10.1016/j.jmmm.2016.10.002

Investigation of magneto-optical properties of ferrofluids by laser light scattering techniques

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Abstract

Investigation of magnetooptical characteristics of ferrofluids is an important task aimed at the development of novel optoelectronic systems. This article reports on the results obtained in the experimental studies of the factors that affect the intensity and spatial distribution of the laser radiation scattered by magnetic particles and their agglomerates in a magnetic field. Laser correlation spectroscopy and direct measurements of laser radiation scattering for studies of the interactions and magnetooptical properties of magnetic particles in solutions were employed. The objects were samples of nanodispersed magnetite (Fe_3O_4) suspended in kerosene and in water. Our studies revealed some new behavior of magnetic particles in external magnetic and light fields, which make ferrofluids promising candidates for optical devices.

Keywords: ferrofluid; light scattering; laser correlation spectroscopy; particles aggregation

1. Introduction

Ferrofluids (FFs) attract considerable attention from the point of view of fundamental research and also possible applications, among which optical devices have recently been discussed [1, 2]. Though ferrofluids were first produced a few decades ago, a lot of questions on their behavior remain to be unanswered. In particular, FFs have nonlinear optical properties which are poorly understood, but which may be used in modern photonic devices [3, 4].

To investigate optical and magnetooptical properties of FFs, the methods based on laser radiation scattering are appropriate. When laser radiation is transmitted through a colloidal medium with magnetic nanoparticles, some important effects can be observed. For example, under the influence of incident light magnetic particles may conglomerate [5]. In addition, external magnetic field can change optical properties of ferrofliuds, for example, it can lead to the formation of elongated clusters or chains [1, 6].

In order to understand the behavior of nanoparticles in a ferromagnetic fluid, a number of different physical techniques are invoked. Among them are optical techniques which give valuable information on ferrofluids properties. This paper reports on the studies involving i) measurements of scattered light and a subsequent analysis of its two-dimensional Fourier transform and ii) laser spectroscopy based on the correlation analysis of scattered radiation.

2. Materials and Methods

2.1. Samples

The objects of our studies were samples of magnetite Fe_3O_4 suspended in water and kerosene solvents. The oleic acid was used as a surfactant that prevented particle aggregation. The average size of the particles was about 7–8 nm and typical concentrations were 0.02 and 0.2 vol. %.