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Experimental and Theoretical Study of the Magneto-Optical Properties of Fe and Fe_3O_4 Nanodispersed Particles

Author: Lali Kalandadze[1]

Co-authors: Omar Nakashidze [1]; Nugzar Gomidze [1]; Izolda Jabnidze ; Miranda Khajishvili ; Kakha Makharadze ; David Jakobia

[1] *Batumi Shota Rustaveli State University*

Studying the magneto-optical properties of nanodispersed iron and magnetite particles is a highly active field at the intersection of condensed matter physics, nanotechnology, and biomedicine. Interest in these nanoparticles arises from their strong magnetic moments combined with unique optical responses at the nanoscale. Despite extensive research on the magneto-optical properties of nanodispersed structures, questions remain regarding how structural parameters such as, particle size and shape, the volume fraction of magnetic particles, and the nature of the surrounding matrix affect these properties [1, 2]. Consequently, continued research in this field remains highly significant and promising. In the present paper, we investigated the magneto-optical properties of Fe and Fe_3O_4 nanodispersed particles in the photon energy range of 1.5–4.5 eV. The generalized Maxwell-Garnett effective-medium theoretical model, commonly used to describe and analyze experimental data in nanodispersed structures, was modified to focus on a single-component nanodispersed system with optically anisotropic particles (ellipsoids) dispersed in a matrix. Our experimental and theoretical findings confirm that the tensor components of the effective dielectric permittivity of iron nanodispersed particles, and consequently their magneto-optical properties undergo significant changes due to variations in particle shape. However, the magneto-optical properties of nanodispersed particles of magnetic oxides are independent of structural parameters and are determined by the electronic energy structure of the magnetic particles.
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References

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