Temperature Dependent Magnetic Properties and Viscosity Dynamics of Barium Hexaferrite Nanoparticles

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Barium hexaferrite (BaFe12O19) is a highly significant material in the field of magnetism, known for its high magnetocrystalline anisotropy, chemical stability, and wide range of applications in magnetic data storage, telecommunications, and sensing technologies. This study investigates the dynamic behavior of magnetic domains within barium hexaferrite nanoparticles, specifically focusing on the time and temperature dependence of magnetic viscosity. The material was synthesized using the co-precipitation method, a process chosen for its ability to produce fine particle sizes and maintain chemical homogeneity. Structural and morphological characterizations were conducted using X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM), confirming an M-Type hexagonal structure with hexagonal platelet-like crystal formations. Magnetic properties were evaluated via Vibrating Sample Magnetometry (VSM). A central focus of this research is the magnetic viscosity, which describes the time-dependent response of magnetization to changes in an applied magnetic field. Experimental findings, illustrated through line and contour plots, demonstrate that magnetic viscosity decreases as temperature rises. This occurs because increased thermal energy at higher temperatures disrupts the orderly arrangement of magnetic domains, leading to increased domain mobility and faster relaxation processes. Conversely, at lower temperatures, reduced thermal energy limits domain movement, resulting in higher magnetic viscosity values and slower relaxation. The study utilizes logarithmic time scales to expose complex details of domain reorientation and relaxation kinetics. These insights provide a deeper understanding of the underlying mechanisms driving magnetic interactions, offering a foundation for the design and development of next-generation magnetic materials with tailored features for stable, high-performance technological applications.

References:

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