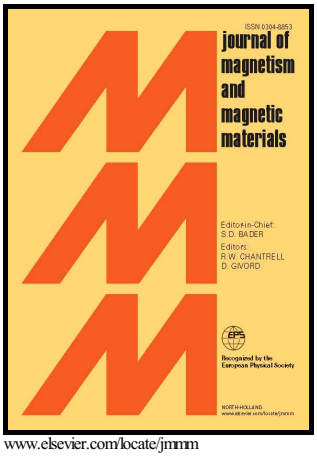

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Structure and viscosity of a transformer oil-based ferrofluid under an external electric field

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Abstract

Various structural changes of ferrofluids have been intensively studied under external magnetic fields. In this work we present an experimental evidence of similar changes induced by an electric field. In the context of the electric field effect on ferrofluids structure, we studied a simple ferrofluid consisting of iron oxide nanoparticles coated with oleic acid and dispersed in transformer oil. The structural changes have been observed both on macroscopic and microscopic scale. We also demonstrate a remarkable impact of the electric field on the ferrofluid viscosity in relation to the reported structural changes. It was found that the electric field induced viscosity changes are analogous to the magnetoviscous effect. These changes and the electroviscous effect are believed to stem from the dielectric permittivity contrast between the iron oxide nanoparticles and transformer oil, giving rise to the effective electric polarization of the nanoparticles. It is highlighted that this electrorheological effect should be considered in studies of ferrofluids for high voltage engineering applications, as it can have impact on the thermomagnetic convection or the dielectric breakdown performance.

Keywords: ferrofluids, electric field, magnetic nanoparticles, viscosity, aggregation

1. Introduction

During the last decades, much effort has been made to explore the structural behavior of ferrofluids and related phenomena when exposed to external magnetic fields. The magnetic nanoparticle interactions and subsequent structural reorganization, aggregates, chains and pattern formation have been intensively studied by various experimental