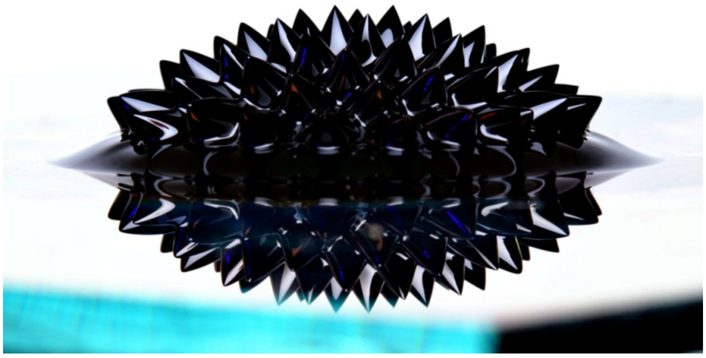

Ferrofluids

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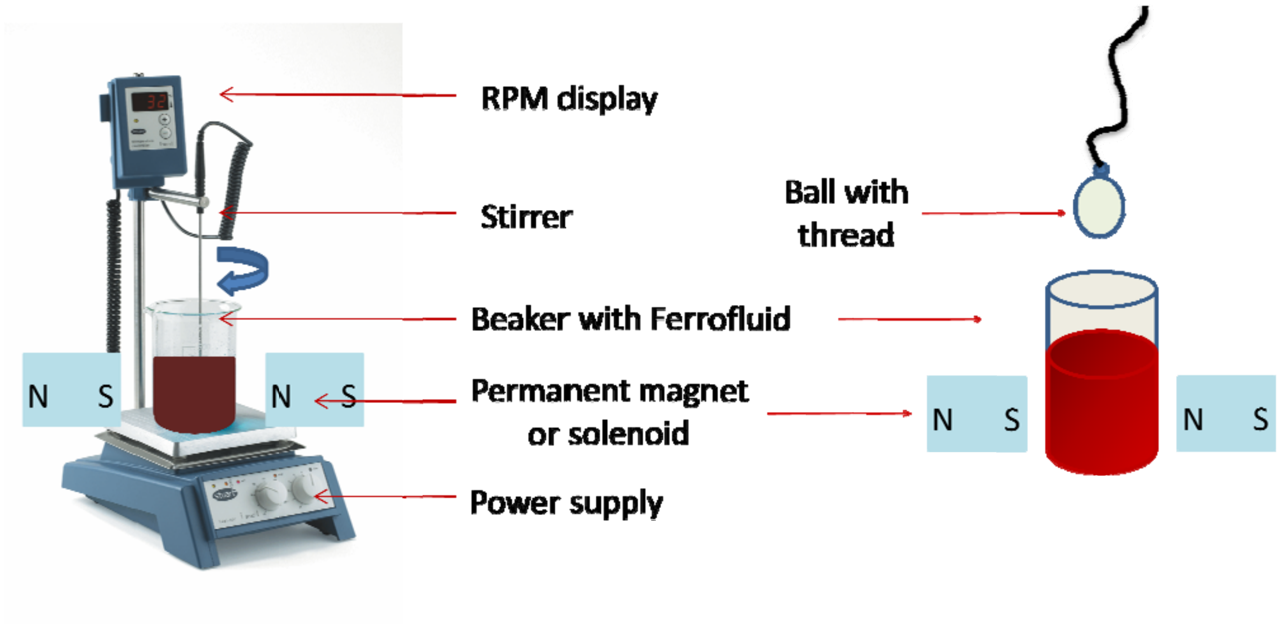
1. Introduction

During the last few decades, there have been considerable interests on nanoscale materials that have structural features in between atoms and bulk materials. Among various nanomaterials, tailoring and understanding the physical and chemical properties of metallic nanoparticles and its dispersions are being intensively pursued due to the fundamental scientific interest of these materials and also due to their immense technological applications.

Ferrofluid (surfactant stabilized magnetic nanoparticles dispersion, typically dispersed particle size ~10nm) responds to external magnetic field and acts as a strong liquid magnet, which can be controlled by external magnetic field. Nanoparticles remain in dispersed condition against settling under gravity due to Brownian motion, adsorbed surfactant layer provides repulsion between particles to prevent agglomeration and also allows to maintain fluidity even at high magnetic fields. As dispersed magnetic nanoparticles are superparamagnetic in nature, an applied field induces a magnetic dipole in each particle and these particles orients towards the field direction, causes them to form chain like structure that can greatly affect macroscopic properties of the ferrofluid even at the lower concentrations of particles in fluid. In absence of external magnetic field, these particles have no permanent magnetic moment because of random orientation of the particles due to thermal motion. This property of ferrofluid has been explored to develop the potential applications in sealing, sound damping, actuators, microchip valves, tunable refractive index media, as optical filters and biomedical applications [MRI contrast agents, DNA detection, cancer therapy and drug delivery systems].

2. Project

The macroscopic properties such as magnetic moment, viscosity, stability are highly dependent on various parameters such as dispersed particle size, composition, nature of surfactant and carrier, compatibility of surfactant with carrier and applied external magnetic field. This project concentrates on the preparation of stable ferrofluid (oleic coated magnetite nanoparticles dispersed in organic solvents) and its dynamic and static viscosity properties in presence of tunable external magnetic field. The preparation process includes the precipitation of ferrous and ferric ions into magnetite (co-precipitation technique), surfactant capping over the particle surface, purification of particles from excess surfactant and reaction byproducts, and its dispersion in carrier fluid. In presence of tunable external magnetic field, the dynamic viscosity can be studied by correlating the stirrer RPM (rounds per minute) for supplied constant power (or vice versa) and the static viscosity by measuring the time required to travel the ball through fluid on gravitational force (Fig. 1).



Dynamic viscosity

(RPM Vs power supply)

Static viscosity

(drop-ball method or weight required to lift ball)

Fig. 1. Schematic diagram of the process to estimate the dynamic and static viscosities with applied field.