Abstract

The aim of this thesis is to test experimentally for the first time whether the theory for field-effects in electrorheological fluids (ERF's) is applicable to compartmentalised water-oil-surfactant mixtures (microemulsions). Both cases represent microdisperse systems, the main difference lying in the fact that the dispersed matter in ERF's consists of rigid particles, whereas in microemulsions a highly dynamic surfactant membrane divides the two fluid sub-phases.

As model-systems water-in-oil microemulsions with the non-ionic surfactant Igepal CO 520 and the ionic surfactant Aerosol OT (AOT) are used and the composition is varied systematically with respect to droplet size, droplet concentration and volume fraction.

By slightly changing the temperature these systems show a rise in electrical conductivity of several orders of magnitude (so-called percolation transition), while staying in the homogeneous one-phase region. When undergoing percolation non-ionic and ionic surfactants exhibit a temperature-inverse behaviour. The present study tries to provide evidence to what extent the microstructure underlying the percolation phenomena differs between different surfactants.

Determination of phase behaviour and measurements of viscosity, electrical conductivity, time-resolved luminescence quenching (TRLQ) and time-resolved electric birefringence provide insights into interactions, compartmental sizes and transport properties.

Systems with the ionic surfactant AOT show complex conductivity behaviour. The borderline between low- and high-conducting regions (= percolation threshold) shows a non-trivial dependence on composition. The performed TRLQ-measurements confirm the fundamental applicability of percolation theory. The phenomenological description of the temperature-dependence of the conductivity is further elaborated in this work and yields some valuable information on the physically relevant factors governing the percolation transition. The field-pulse experiments show the non-applicability of ERF-theory to ionic AOT-systems. The compartments consist of aggregated droplets which maintain their integrity and only provide a weak coherence of the compartment. The influence of the counter-ions on the surfactant membrane leads to complicated interactions.

In the non-ionic Igepal-system the field-pulse experiments allow the determination of compartment sizes in two independent ways. The size can be extracted from critical fields based on ERF-theory, and on the other hand from field-off relaxation-times which were evaluated using a kinetic scheme developed in this study. Both methods provide consistent values which are also compatible with the scaling laws from percolation theory.

Non-ionic microemulsions exhibit, at least partly, properties of electrorheological fluids. The critical fieldstrength can therefore be used as an independent measure for the characterisation of aggregate sizes.