Mechanism of the cooperative relaxation in microemulsions near the percolation threshold

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Abstract

Cooperative dynamics of three-component water-oil-surfactant microemulsions based on sodium bis(2-ethylhexyl) sulfosuccinate surfactant were investigated near the percolation threshold. The measurements were made by means of the time domain dielectric spectroscopy method in the temperature interval 12 °C-40 °C, including the percolation range. The data treatment was carried out in time domain in terms of the macroscopic dipole correlation functions (DCFs) related to the structural and kinetic properties of the system. It is shown that the DCF can be described by the Kohlrausch-Williams-Watts (KWW) expression $\exp[-(t/\tau)^\nu]$ (where τ is the relaxation time and ν is the stretched parameter), reflecting the peculiarities of the dipole interactions in a self-similar medium. For a physical interpretation of the phenomenological parameters τ and ν, a generalization of the known model of the cooperative relaxation was made. The model developed was adjusted for a description of the relaxation in microemulsions that have a fractal nature in the percolation region. The results obtained testify that parameters τ and ν in the KWW function are related to the structure of the system and reflect the cooperative behavior of microemulsion droplets near the percolation threshold. It was shown also that the macroscopic law of the relaxation of the KWW type is insensitive to the microscopic details of charge transport in the system and that there is a limited temporal range for the applicability of the stretched law of relaxation in time domain. In order to extend the initial temporal interval of the applicability of the relaxation function the correlation to the KWW term was found.