Mesoscopic Properties of Aqueous Solutions

Deepa Subramanian [C, S] and Mikhail Anisimov
University of Maryland, Department of Chemical and Biomolecular Engineering, College Park, Maryland, U.S.A.
deepas@umd.edu

Aqueous solutions of certain low-molecular-weight nonelectrolytes and electrolytes, such as alcohols, amines, ethers, or salts, are considered macroscopically homogeneous. However, occasionally mysterious mesoscale inhomogeneities, of the order of a hundred nm in size, are reported in these aqueous solutions. The existence and nature of these inhomogeneities are largely debated in the literature, with views ranging from genuine structural phase transitions to experimental artifacts, from loose supramolecular structures to kinetically arrested gaseous nanobubbles. In order to resolve this controversy, we have carried out comprehensive static and dynamic light scattering and confocal microscopy experiments on aqueous solutions of tertiary butyl alcohol and propylene oxide. Based on our results, we hypothesize that the mesoscopic inhomogeneities are akin to a micro phase separation, which occur due to a competition between the hydrogen-bonded aqueous solution structure, of aqueous tertiary butyl alcohol solutions, and the tendency to phase separate, upon addition of propylene oxide. Long-term stability investigation of these inhomogeneities has revealed that they are exceptionally long-lived, non-equilibrium structures that persist for weeks or even months.