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Dynamics on Multiple Time and Length Scales in Complex Fluids Formed by Conjugated Polymers[1]

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Even though tremendous effort takes place to incorporate conjugated polymers into device applications, there is a significant gap in performance of the optimal desired devices developed. While the photo physics of highly conjugated polymers has been intensively investigated, the factors that affect the conformation and assembly and the dynamics on multiple length scales, that ultimately control the electro-optical response, have not been resolved. Using poly(*para*phenyleneethynylene)s (PPE) as a model system for conjugated polymers, our studies have identified the driving forces for different association modes of PPEs as a function of their chemical structure and their interactions with solvents. X-ray and neuron scattering, probing dimensions from 0.1 to 100nm, revealed that PPEs dissolved in toluene form a rich variety of complex fluids. At high temperature the molecules are isolated and assume extended configuration. As the temperature decreases, the molecules associate and eventually form gels of different nature. In higher concentrations ordered phases are formed. Inelastic Neutron Back Scattering together with Neutron Spin Echo were used to study the dynamics on multiple length scales at the different complex fluids, exploring processes of 5-100 nano seconds. The dynamic scattering function incorporates the center of mass diffusion together with intramolecular motions. With decreasing temperature the PPE molecules aggregate and their center of mass diffusion is hindered. At the gellation transition the center of mass diffusion is no longer observed where as the intramolecular dynamics is retained in all phases. Cooperative dynamics of the solvent and PPE molecules has been observed in both molecular solution and micellar phase. The phases formed by PPEs are optically active where the dynamic processes affect directly their optical characteristics.

[1]The studies are carried out in collaboration with Naresh C. Osti, Yunfel Jian, and Dilru R. Ratnaweera, Clemson University, Madhusudan Tyagi, from NIST and Uwe H.-F. Bunz from Georgia Institute of Technology.