

## Abstract

Biomolecules present in the cellular environments and the water dynamics around the molecule plays a crucial role in controlling their structure, dynamics and reactivity. However, due to the several complexities arises from the biological systems they are beyond that commonly encountered in physical as well as chemical sciences. Thus, different microheterogeneous confined systems (such as micelle, reverse micelle/microemulsions, vesicles etc.) have been developed which can be used as a model of the complex biological systems. The structure and dynamics of these assemblies can be monitored using different spectroscopic techniques. Particularly, fluorescence spectroscopy (ensemble average as well as single molecule measurements) is used in the field of physics, chemistry and biology to monitor a wide range of molecular processes such as water dynamics, rotational dynamics and conformational changes of biomolecules etc. In this thesis, we present the preparation and characterization of different microheterogeneous systems composed of surfactants, polymers or room temperature ionic liquids (RTILs) and we investigate different photophysical and dynamical processes in these confined systems which provide much important information for their future applications.

We have showed that how the suitable selection of the RTILs can modulate the structure and dynamics of aggregates and cosolvents. We have performed solvation dynamics, rotational as well as translational diffusion to probe the structural alteration of the systems. Further, we studied the DNA condensation into the core of the reverse micelles (RMs). We have used berberine chloride as an alkaloid to monitor the interaction between DNA and RMs using different time resolved fluorescence techniques. Using fluorescence lifetime imaging microscopy (FLIM) and fluorescence correlation spectroscopy (FCS) we have demonstrated the adsorption of different fluorophores on graphene oxide (GO) surface. GO can be used for multimodal imaging which includes cell imaging and in vivo micro-CT imaging. Further, we have studied the ESIPT dynamics of probe molecule during pH responsive micelle to vesicle transition of fatty acids and fatty acid vesicle can be fused in presence of different electrolytes. The FLIM based approach of vesicle fusion provides a better insight into the growth of protocell membrane.

**Keywords: Self assembly, Microheterogeneity, Time resolved fluorescence spectroscopy, FCS and FLIM.**