Chapter 4

CONCLUSIONS

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Lysozyme-[60]fullerene adduct was synthesized and found to be highly water soluble. All the characterizations that were done conforms that the interaction between the [60]fullerene and the lysozyme is hydrophobic in nature. Noncovalent interaction is formed between [60]fullerene and lysozyme, which highlights that lysozyme acts as the one of the useful water soluble supramolecular host that makes adduct with [60]fullerene. These studies show that there is a strong possibility for hydrophobic interactions between the various proteins and [60]fullerene in the biological milieu, when the [60]fullerene-lysozyme adduct is used for biomedical applications, unless the molecule is delivered effectively at the intended site of action.

It has been found that [60]fullerene forms reverse micelles with the structurally different non-ionic surfactants and shows an identical break point giving the exact value of critical reverse micelle concentration, on the basis of which the thermodynamic quantities such as standard free energy; enthalpy and entropy of reverse micellization were calculated and are found to be negative. This shows that the process of reverse micellization is spontaneous and exothermic. The study suggests that reverse micelle of Span60 and Brij35 provides a hydrophilic core, suitable for the [60]fullerene and it is accommodated in its core. A polar head group of the Span 60 as well Brij 35 had a strong hydrophobic interactions between the surfactant and [60]fullerene core.

Phase diagrams have been drawn to understand the behavior of the [60]fullerene in the microemulsion system and from the phase diagrams we found that in the presence of fullerene the area of the monophasic microemulsion region is increased than that of in the absence of fullerene. With the increase in the cosurfactant amount, more amount of water is required for the formation of the emulsion. A two phase system means that the microemulsion system requires the presence of cosurfactants for the formation and stability. These results can be extended to increase the solubility of [60]fullerene in polar medium by either using single surfactant or by use of mixed surfactants. By studying the effect of mixed surfactant systems we have observed that the stable microemulsion is formed but the area of the monophasic microemulsion region was does not show a big change in the value and that was same as in case of single surfactant system. This indicates that [60]fullerene forms the stable microemulsion with single as well mixed

non-ionic surfactant systems. The results obtained during all these studies shows the surfactant nature as one of the unique feature of the [60]fullerene.

A third generation water-soluble host molecule i.e. calixarenes was achieved by the attaching sulfonate and diallyl amine group on the upper rim of the calix[8]arene molecule resulting in to p-sulfonatocalix[8]arene and [p-(N, N-Diallylaminomethyl)] calix[8]arene respectively. These two compounds were found to be highly water-soluble and act as water-soluble hosts for the [60]fullerene. Supramolecular complexes of [60]fullerene with these water-soluble calix[8]arene molecule were formed and characterized. [60]fullerene was encapsulated in the cavity of both p-sulfonato calix[8]arene and [p-(N, N-Diallylaminomethyl)] calix[8]arene which makes [60]fullerene it self hydrophilic in nature. Mainly the interaction of these two water-soluble host molecules with the [60]fullerene were studied and it was observed that [60]fullerene forms a non-covalent interaction with p-sulfonatocalix[8]arene. These synthesized supramolecular complexes of [60]fullerene are useful for getting water-soluble polymers.

A solvent free synthesis of β, γ-cyclodextrin-[60]fullerene complex was done and was found to be highly water-soluble. Characterizations show that each fullerene molecule was encapsulated by two cyclodextrin molecules. After irradiating γ-CD-[60]fullerene complex under UV it shows its response in the magnetic field. Even though the capping was there and the overall response being diamagnetic, there seems to be some component of ferromagnetism which is new. This unique property of the water-soluble γ-cyclodextrin-[60]fullerene complex can be useful as a bio-medical application specially for the MRI studies.

All these synthesized supramolecular complexes of [60]fullerene with various water-soluble hosts like lysozyme , non-ionic surfactants, p-sulfonato calix[8]arene and [p-(N, N-Diallylaminomethyl)] calix[8]arene and β, γ-cyclodextrin shows a non covalent interactions with [60]fullerene and show potential for a wide range of applications in the bio-medical field.