Molecular Assembly of Fullerenes as Nanoclusters and Films

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Utilization of fullerene materials for developing next generation nanodevices requires preparation of robust films on desired electrode surfaces with a well-controlled morphology. Fullerenes and their derivatives form clusters in mixed solvents, which are optically transparent and thermodynamically stable. Recent studies

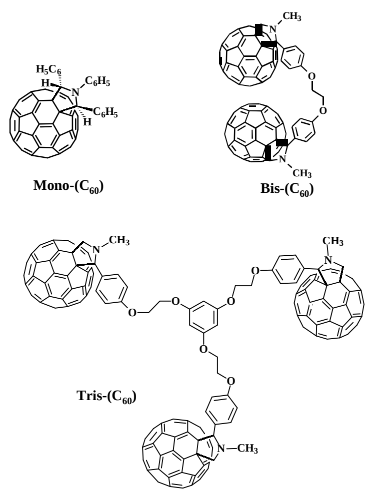

Chart 1

have demonstrated interesting photochemical and photoelectro-chemical properties of fullerene-based cluster systems. Since these clusters have thousands of randomly associated fullerene units it is difficult to establish the factors that influence the charge stabilization properties. A proper design of molecules that contain controlled number of fullerene units can provide basic information on the cluster systems. The results that elucidate electrochemical, photophysical and photochemical behavior of the monomer and cluster forms of bis- and tris-derivatives of C_{60} (Chart 1) will be discussed. The molecular clusters of these fullerene derivatives formed in toluene-acetonitrile mixed solvent are optically transparent as they form interesting nanostructures with size ranging from 100 nm to 1μm and shapes varying from elongated wires to entangled spheres.

Fullerenes being strongly hydrophobic in nature prefers to form clusters so as to minimize its nonpolar surface exposed to the polar surrounding in the mixed solvent. If linear stacking is the dominant pathway for bis-C_{60} molecules to aggregate one would expect the clusters to grow preferentially in one direction. Elongated rod or wire type structure observed in in TEM images gives credence to such an argument. Aggregation of tris-C_{60} on the other hand, has a geometric possibility to from clusters in a three dimensional fashion. A template driven clustering can further aid in defining the shape and size of these clusters.

The C_{60} clusters can become charged under the influence of a dc electric field and get deposited on an electrode surface. The ability to assemble the fullerene clusters as 3 dimensional arrays opens up new avenues to design high surface area electrode materials that are potentially useful for developing chemical sensors and light energy conversion devices. Atomic force microscopy studies that evaluate the morphology of nanostructured C_{60} films prepared by electrophoretic deposition method will be presented.

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