Development of new Polymers and Composite Materials for Organic Photovoltaics and Dye Sensitized Solar Cells

E.K. Pefkianakis, A.A. Stefopoulos, A.K. Andreopoulou, C.L. Chochos, V.G. Gregoriou and J.K. Kallitsis

Department of Chemistry, University of Patras, Patras 26500, Greece and Foundation for Research and Technology Hellas, Institute of Chemical Engineering and High Temperature Processes (FORTH-ICEHT)

The development of the various renewable energy technologies, aim in the long run, to efficiently contribute to the solution of energy problem in both economic and environmental aspects. The conversion of solar energy into electricity using organic or polymeric materials represents a globally evolving field of research, showing great technological and industrial interest, due to the fact that it constitutes an alternative solution compared to the classic inorganic Photovoltaic systems. Thus, the materials science in general, has devoted great efforts towards the development of new and efficient energy related systems with many achievements in the area of Organic Solar Cells which are categorized to Cells of Small Organic Molecules, Fully Polymeric/Plastic Cells and Dye Sensitized Cells.

In these emerging areas, our group has mainly focused on the development of novel polymeric materials for Plastic and Dye Sensitized Solar Cells. In the field of Plastic Photovoltaics, we have so far developed new polymers with electron acceptor properties, which have been combined with polymeric donors, resulting in bulk heterojunction architectures. As the electron donor/acceptor or even transporter segments, derivatives of oxadiazole, carbazole, quinoline, fluorene and thiophene monomers have been utilized. The combination of these moieties produced polymeric “architectures” with nanophase separation and were extensively characterized in respect to their molecular characteristics and optoelectronic properties. Such homopolymers and random or block copolymers were prepared through radical polymerization techniques (e.g. Atom Transfer Radical Polymerization) and cross-coupling polymerizations.

Our main objective in Dye Sensitized Cells, has been the replacement of commonly used dyes (complexes of transition metal ions with small organic molecules), with polymeric dyes, introducing the advantages of polymers in Sensitized Solar Cells. Thus, we managed in synthesizing a variety of highly loaded, soluble metallopolymeric complexes of the Ruthenium (II) ion, with tridentate or bidentate ligands like 2,2’:6’,2’’-terpyridine or 2,2’-bipyridine, respectively.

Recently our laboratory has also been involved in the rapidly evolving technology of Carbon Nanotube modification (CNTs). In this direction polymer modification of Single Wall Carbon Nanotubes was successfully attempted, in order to develop new composite materials that combine the electron donor or acceptor properties of the covalently attached polymers with those of the CNTs. The final products were fully characterized with all the conventional methods employed for CNTs, as well as for their optoelectronic properties.