Abstract

This dissertation is based on the optoelectronic properties of different organic semiconductors for their photovoltaic applications. The need of alternative renewable energy sources has stimulated new scientific research for photovoltaic devices and organic semiconductors have shown the potential of obtaining the cheap and easy methods to produce electrical energy from sun.

Photovoltaic properties of pentacene/N,N'dioctyl-3,4,9,10 perylenedicarboximide (PTCDI-C_8) discrete heterojunctions have been investigated. The effects of annealing temperature on their photovoltaic properties have also been investigated. Strong light harvesting properties throughout the visible region of solar spectrum was observed for the devices. From absorption spectrum and the photocurrent action spectrum, PTCDI-C_8 molecule appears to be an interesting choice as an acceptor material for photovoltaic applications.

Self-assembled organic nanostructures such as PTCDI-C_8 nanoribbons and copper phthalocyanine (CuPc) nanorods of different shape, size and orientations have been synthesized and tested for their photovoltaic applications. They have been found to be extremely promising materials for fabrication of controlled bulk heterojunction solar cells as they offer large donor/acceptor interface area for efficient exciton dissociation as well as continuous pathways for rapid charge extraction without much recombination losses.

Various effects of p-type and n-type doping on the charge transport and photovoltaic properties of small molecule organic photovoltaic devices (OPVs) were investigated. Doping level of active layers has been optimized to improve the device efficiency. A twofold increase in power conversion efficiency was observed with doping.

OPVs degrade during illumination and as well as in the dark. Long operational lifetime of solar cell devices is one of the primary requirements for their real life applications. A systematic study has been carried out to understand the degradation mechanism. Various effects of environmental conditions on device lifetime have been investigated. The parameters responsible for the device degradation and failure are identified.

Key words: Organic semiconductors, organic photovoltaic cells, pentacene, PTCDI-C_8, CuPc, doping, degradation.