Abstract

This dissertation deals with the optoelectronic properties of organic semiconductor based thin film devices like light emitting diodes, solar cells and memory devices. Organic semiconductors not only offer a possibility of fabricating cheaper version of conventional devices, but also provide an opportunity to fabricate novel devices at the molecular level.

Indium tin oxide is widely used as the transparent electrode of organic light emitting diodes (OLEDs) and solar cells. The effect of substrate temperature and annealing environment on the structural, electrical, optical and morphological properties of ITO thin films has been investigated. The photo-physical properties of poly[2-methoxy-5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene] (MEH-PPV) films have been investigated using temperature dependent photoluminescence spectra. The transport mechanisms and relaxation processes of single layer polymer light emitting diodes based on MEH-PPV are investigated. In the low voltage region charge conduction is dominated by ohmic conduction. Whereas, at higher voltages conduction mechanism changes to space charge limited current conduction with exponential trap distribution.

Organic nonvolatile memory devices have attracted considerable attention due to their low cost and high performance. Multilevel conductance switching in organic memory devices based on tris-(8-hydroxyquinoline)aluminum (AlQ_3) and Al/Al_2O_3 core-shell nanoparticles is demonstrated. The effect of the thickness of middle aluminum layer and the size of the nanoparticles on device performance is investigated. Field induced transfer of charge carriers between AlQ_3 and aluminum core is proposed to be responsible for conductance switching.

Organic semiconductors have high optical absorption coefficients ($\approx 10^5$ cm^{-1}) which offer the possibility for the production of very thin photovoltaic cells. Photovoltaic properties of the devices based on pentacene/[6,6]-Phenyl C_{61} butyric acid methyl ester (PCBM) bilayer hetero-junctions, were investigated. The crystalinity of pentacene on ITO substrate was found to increase after the deposition of poly (3,4-ethylene dioxythiophene) doped with poly (styrene sulfonate)(PEDOT:PSS) layer. The increased crystallinity of pentacene resulted in an improved device characteristics.

Key words: Organic semiconductors, optoelectronic properties, organic light emitting diodes, organic bistable memory devices, organic photovoltaic cells