ABSTRACT

Title of the Thesis: Charge Trapping Mechanism in Organic Semiconductor Devices

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The organic materials are being widely investigated to develop different electronic and optoelectronic devices. Organic devices are more flexible, light weight, cost effective and can be easily fabricated over a large area. Organic semiconductor devices are attractive because the properties of amorphous thin films of organic materials can be attuned over a wide range and they can also be deposited at low temperatures on substrates such as glass, plastic etc. to make feasible devices by using low cost manufacturing techniques. Despite these advantages, there are also certain limitations of organic devices. One of the limitations is organic devices are susceptible to traps which leads to high barrier potential at metal-organic layer interface. Charge injection of these devices at the metal – organic interface is poor due to the existence of traps. Barrier height and depletion layer width of metal – organic interface are typically high due to interfacial trap density. However, there aren't many studies for organic semiconductors to determine these above mentioned parameters at metal – organic interface when traps are present.

In this context, interfacial barrier, trap concentration, depletion layer width, band bending, image force barrier lowering and barrier inhomogeneities at interface considering charge trapping effect have been discussed in this present work. The different charge trapping models and its effect on charge injection process and different charge injection models have also been studied. The interfacial barrier height has also strong correlation with the interfacial band bending and image force barrier lowering effect of these organic devices. We have calculated these parameters from I-V plots of these devices and correlate it with the trap energy at metal – organic interface. We have also observed the effect of Zinc Oxide (ZnO) nanoparticles, Titanium dioxide (TiO_2) nanoparticles, Single Walled Carbon Nanotubes (SWCNT) and Multi Walled Carbon Nanotubes (MWCNT) on these parameters of the series of organic dyes such as Phenosafranin (PSF), Safranin –T, Malachite Green (MG) and Methyl Red (MR) dyes. We have also studied the back electrode effect on the junction parameters of Crystal Violet (CV) dye based devices. This work will be helpful to overcome some concerns linked to charge trapping and charge injection processes at metal - organic contact.

N B Manik

Signature of the Supervisor
(With Seal)

Date: 24.04.2023

Dr. NABIN BARAN MANIK
Professor
Department of Physics
Jadavpur University
Kolkata - 700 032

Sudipta Sen

Signature of the Candidate

Date: 24/04/2023