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Title of the thesis : **Transport and Interface Study of Hole Transporting Organic Semiconductors**

Abstract of Thesis

Organic semiconductors (OSCs) are dragging huge attention due to their potential application in all electronic devices because of easy processing and low-cost fabrication. But due to low life time and efficiency of devices requires the fundamental knowledge of injection and transport mechanism in OSCs and morphological stability in their films. In this thesis, we have studied the transport mechanism in two hole transport materials *2,2',7,7'-tetrakis-(diphenylamino)-9,9'-spirobifluorene* (Spiro-TAD) and *2,2,7,7-tetrakis-(N,N-di-4-methoxy phenylamino)-9,9'-spirobifluorene*(Spiro-MeOTAD) by static and dynamic conduction mechanism.

(a) **Static and Dynamic electrical conduction in Spiro-TAD and Spiro MeO TAD films:** For static and dynamic electrical studies, hole only devices of Spiro-TAD and Spiro MeO TAD films have been fabricated. In **static** conduction, it has been observed that the J-V characteristics showed an injection limited behavior in Spiro-TAD films but ohmic contact in Spiro MeO TAD. The injection barrier height between ITO/Spiro-TAD has been calculated using RS model and barrier reduced by an optimized thin layer of F_4TCNQ. The temperature dependent J-V characteristics of interface modified Spiro- TAD and Spiro MeO TAD device have been analyzed in the framework of SCLC model including a field and temperature dependent mobility. The mobility is fitted with well known Gill's model and Gaussian disorder models. Then Gaussian disorder parameters like energetic disorder (σ), and positional disorder (Σ) have

been evaluated in both cases. It was found that Spiro MeOTAD films are more ordered than Spiro-TAD films. In **dynamic studies**, the bias and temperature dependent transport properties of both materials have been studied. Spiro-TAD, leads to the injection limited conduction by showing very high resistance (~ 10^7 Ω) in Cole-Cole plost. After the interface modification, devices show decrease in bulk resistance at different applied bias voltages and can be modeled as the combination of double parallel resistor capacitor (R–C) circuits with a series resistance. Debye type relaxation have been observed in bulk. Resistance and junction of capacitance were found to decrease with the increase in voltage, while bulk capacitance remains unchanged. Devices with interface modification exhibits the space charge limited (SCL) conduction with field dependent mobility which was further verified by Capacitance –frequency curves. The temperature dependent impedance and conductivity analysis of Spiro-TAD shows NTCR type behavior and short-range translational type hopping of charge carriers. Similar behaviour has been observed in case of Spiro MeO TAD devices.

(b)Work function measurements and OLEDs fabrications: Work functions of different metal surfaces after deposition of F_4TCNQ have measured using SKM. There is enhancement in work function of substrates with incorporation of F_4TCNQ on surfaces. After about 7 nm, the enhancement shows saturation that explained on the basis of integer charge transfer model. Using AFM and Optical measurements, the morphological studies show that thin films of both HTLs Spiro-TAD and Spiro-MeOTAD were smooth and stable. These stable films are used in fabrication of OLEDs. By comparing OLEDs, it was found that the interface modified Spiro-TAD device show lower operating voltage, higher luminescence and higher current efficiency due to proper charge balancing.