Abstract

Title: Investigation on the Effect of Trap States Signature on the Charge Transport Mechanism of Some Natural Organic Semiconducting Material based Devices

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The thesis deals with the illustration of charge transport into the active layer of natural dye based organic diode by using current-voltage (I-V) plot analysis. Very few earlier investigations have reported that natural organic materials (e.g. turmeric dye, indigo dye) have semiconducting properties. Since the semiconducting properties in natural dyes are hot debated concern, so much study still remains to be done in order to completely realize the physics regulating the whole mechanism. The work has been initialized in this context to have a better insight of the charge transport mechanism in organic semiconductors. Disordered amorphous nature of organic semiconductors is prone to traps. Organic dye based devices exhibit poor performance due to the presence of trapping states. Having a better knowledge at first on trap assisted charge transport is primarily required to resolve such problem. The analytical explanation of signature of traps in charge transport process of turmeric dye based organic semiconductor has been demonstrated here in the work. Differential analysis has also been done to validate the outcome of our explanation. Multiple distortions with non monotonous nature obtained in differential verification ensure the existence of trapping states into such devices. A series of electronic parameters implicitly or explicitly related to trap distribution have also been estimated from aforementioned graphical analysis. Similar treatment has been executed for indigo dye based organic diode which shows significant consistency with the aforesaid outcomes. Present experimental outcome reveals that the natural organic dyes under experiment have quite less trap energy and subsequently these dyes exhibit promising outcome of trap states associated other electrical parameters in comparison to some earlier reported organic semiconductors.

On the other hand, charge conduction in drift regime of organic diodes has extensively been investigated whereas drift-diffusion model has only lately attracted significant concern. So finally focus has been given in this aspect. Theoretical illustration of equations related to diffusion driven current has been implemented to study the charge transport mechanism. Data obtained from GPVDM software simulation has been fitted in diffusion driven conduction based equation which shows high consistency together. Effect of trap distribution produced by high energetic disorder in this regime has been observed on the barrier potential and band bending at drift-diffusion interface. Trap assisted carrier transport at low voltage regime and its relation with ideality factor at diffusion prone region has been explained on the basis of analytical approach. It has been obtained in our analytical work that ideality factor exponentially decays with increasing trap distribution at low voltage. Experimental outcome in this context shows great accuracy with theoretical calculations.

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