ALOKE KUMAR DAS **Index No: 132/22/Phys./28**

Title of The Thesis- Study on the charge transport mechanism of natural dye-based organic Schottky diodes

Abstract

In this thesis we have studied the **charge transport mechanism in natural dye-based organic semiconductor Schottky diodes** and found the semiconducting property of natural herbal dyes like turmeric, indigo, and beetroot. The natural dyes show the semiconducting property which has been concluded from the band gap measurement using absorption spectra and temperature dependent dark I-V characteristics. The linear behaviour of the barrier height(ϕ) vs 1/(ideality factor (n) graph confirms the device is a Schottky diode. Moreover, we found that the reverse leakage current is dominated by Schottky emission (SE) over Poole-Frenkle emission (PFE), and from the temperature dependent I-V, the values of β are noticeably closer to Schottky emission lowering coefficient (β_{SE}) than Poole-Frenkle emission lowering coefficient (β_{PFE}). Which concludes that at high temperature SE is dominant PFE and at very low temperature PFE dominant SE. At 140 K the beetroot dye behaves like insulator and the observed parabolic conductance concludes that quantum tunnelling takes an important role in charge transportation. Using Poisson's equation, we extract the mobility, carrier concentration, and trap density in Al/beetroot/Cu Schottky diodes. The mobility is notable for reaching 124.54 $cm^2/V \cdot s$, indicating effective charge transport. The diode is a potential rectifier due to its sensitivity, nonlinearity, and asymmetric current-voltage characteristics. Again, a simulation study was run using the SCAPS 1d program to confirm the findings of the experiment. The value of conductivity and forward bias current is quite low for all these natural herbal dye-based organic semiconductor devices. Again, we observed that due to the incorporation of ZnO nanoparticles the R_s, n, and ϕ of the Schottky diode have significantly decreased, which increase the charge carrier's mobility and current conduction in the natural beetroot dye-based Schottky diode. Finally, we may conclude that spherical ZnO nanoparticles have been founded to reduce R_s, n and ϕ more than cylindrical ZnO nanoparticles do for both types of Schottky diodes. There have been reductions of 91%, 11.5%, and 8% in series resistance (R_s), trap energy (E_t), and barrier height (ϕ), in that order.

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