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Barrier Characteristics of Molecular Semiconductor-Based Organic/Inorganic Au/$C_{42}H_{28}$/n-InP Hybrid Junctions

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Abstract : Thin film of polycyclic aromatic hydrocarbon rubrene, $C_{42}H_{28}$ (5,6,11,12-tetraphenyltetracene), has been surfaced on Moderately Doped (MD) n-InP substrate as an interfacial layer by means of spin coating technique for the electronic modification of Au/MD n-InP structure. Ex situ annealing has been carried out at 150 °C for three minutes under a brisk flow of nitrogen for the better adhesion of the deposited film with the substrate surface. Room temperature electrical characterization has been performed on the $C_{42}H_{28}$/MD n-InP hybrid junctions by current-voltage (I-V) and capacitance-voltage (C-V) measurement in the dark. It has been seen that the $C_{42}H_{28}$/MD n-InP structure demonstrated extraordinary rectifying behavior. An effective barrier height (BH) as high as 0.743 eV, along with an ideality factor very close to unity (n=1.203), has been achieved for $C_{42}H_{28}$/n-InP organic/inorganic device. A thin $C_{42}H_{28}$ interfacial layer between Au and MD n-InP also reduce the reverse leakage current by almost four orders of magnitude and enhance the BH about 0.278 eV. This good performance of the device is ascribed to the passivation effect of organic interfacial layer between Au and n-InP. By using C-V measurement, in addition, the value of BH of the $C_{42}H_{28}$/n-InP organic/inorganic hybrid junctions have been obtained as 0.796 eV. It has been seen that both of the BH value (0.743 and 0.796 eV) for the organic/inorganic hybrid junction obtained I-V and C-V measurement, respectively are significantly larger than that of the conventional Au/n-InP structure (0.465 and 0.503 eV). It was also seen that the device had good sensitivity to the light under 100 mW/cm^2 illumination conditions. The obtained results indicated that modification of the interfacial potential barrier for Metal/n-InP junctions might be attained using polycyclic aromatic hydrocarbon thin interlayer $C_{42}H_{28}$.

Keywords : I-V and C-V measurements, heterojunction, n-InP, rubrene, surface passivation
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