IMPEDANCE OF POLY(3-METHYLTHIOPHENE) -BASED SCHOTTKY BARRIER DIODES

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Poly(3-methylthiophene) (P3MT)-based Schottky barrier diodes were prepared by electropolymersiation of methythiophene either ITO-coated glass substrates or a Platinum sheets. The structure was completed by depositing tungsten or molybdenum circular top electrodes by RF-sputtering. A stainless-steel plate was used as the counter electrode (CE) and the deposition voltage was fixed at +7 volts. The electrolyte was composed of propylene carbonate (solvent) and tetrabutylamonium perchlorate (0.02M).
We recently reported on the analysis of the dark I-V characteristics of these devices[1,2]. Here, we present a detailed analysis of the temperature, frequency and DC-bias dependence of the impedance of these diodes.
The loss tangent of these structures shows a broad maximum whose position vary with the temperature according to an Arrhenius law. An average activation energy of 0.3 eV is deduced from the position of this
maximum in accordance with the activation found from the saturation current of the structures. However, it is found that the simple model, in which only the depletion layer, the neutral zone, and an eventual contact resistance are considered, does not accurately account for the frequency dependence of the measured impedance in the studied frequency range (40 to 1MHz) and at different temperatures and DC biases.
An improved model in which an intermediate layer and a constant phase element are added lead to better fits of the experimental results. The intermediate layer, which is found to have a higher conductivity, may originate from the doping process (reduction) of the polymer and is possibly located near the back (Pt) contact. On the other hand, the constant phase element may be attributed to the surface roughness of the polymer or a distribution of relaxation times, which both may lead to distributed-element behavior of the impedance of the devices.
This model enabled to accurately extract the depletion capacitance and to determine the doping density of the polymer and the built potential of the barrier. The results obtained from the impedance measurements are in agreement with those found from I–V characteristics of these diodes.

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