

504/E1

Study of double junction effect on the quantum efficiency of optical devices

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In practical optical devices one of the most important parameters which determine the performance of the device is the quantum efficiency. Generally, an optical device is fabricated using a junction between two semiconductors or a junction between a metal and a semiconductor. However, in practice formation of unwanted junctions during the fabrication stage of the optical devices is a major problem as it results in the reduction of the overall performance of the device. In this investigation, a theoretical study was carried out on an optical device made by using a semiconductor/ metal junction to study this effect. The formation of an additional junction at the back contact was considered as the reason for the formation of a double junction.

In the study, photo induced charge separation at the two space charge layers was considered as the main contribution to the photocurrents. Both drift current and diffusion current of the majority and minority carriers are considered in the continuity equation for calculating the total current produced by the device. Absorption of photons in the semiconductor was calculated using the variation of the absorption coefficient with the wavelength of the direct band gap semiconductor Cu_2O . In solving the continuity equation, the absorption of light in both space charge regions and creation of electron- hole pairs and the motion of the carriers in opposite directions were considered.

The computed variation of the quantum efficiency with the wavelength of the incident light was in agreement with the reported experimental results. We observed that the efficiency of the device is drastically reduced as a result of the double junction effect. Further, with our model it was possible to explain the observation of the variation of direction of photocurrent with the wavelength, as a result of the existence of a double junction. In conclusion, using the computed quantum efficiency variation with the wavelength it was possible to obtain the junction parameters of an optical device using experimental data.