ABSTRACT

The measurement of carrier lifetimes plays a vital role for the identification of impurities in the semiconductor material of solar cell thereby providing a clear insight of the material quality. Many conventional methods like microwave photo-conductance decay, surface photo voltage method are available to measure this parameter but mostly require prior surface treatment called passivation and are dependent on recombination processes. In this present investigation, impedance spectroscopy technique (IST) has been extensively used to measure carrier lifetime and other parameters in silicon wafers as well as solar cell. This technique allows the separate measurement of both the generation and the recombination lifetime. The solar cell structure was realized as an induced p^+-p-n structure which was formed by deposition of semitransparent layers of low and high work function aluminium and palladium metals respectively on both the sides of silicon wafer by electron beam evaporation method. The two metal films create inversion and accumulation layers on the p-type silicon forming induced p^+-p and p-n junctions respectively. Therefore, p^+-p-n structure is formed without involving any high temperature process step and therefore there is no diffusion of impurities inside the semiconductor. Both the generation and recombination lifetime have been measured under the reverse and forward bias conditions respectively. The generation lifetime was estimated to be around 21.4μs and 21.3μs whereas the effective recombination lifetime was estimated to be about 2.09μs and 2.12μs respectively. The effective recombination lifetime was measured on the same sample prior to the formation of the structure by the microwave photoconductive decay method and was obtained to be 2.29μs and 2.30μs which is in close agreement with the measured value estimated by IST. Moreover, from the C-V data deduced from the best fit data (IST) and I-V measurements on the device, parameters like the series resistance (R_s), diode ideality factor (n), barrier height (V_{bi}) and shunt resistance were obtained. Thus, IST is an elegant tool to effectively measure all the relevant parameters of the material prior to formation of an actual device like solar cell.

Keywords: Carrier lifetime, Silicon solar cell, Induced structure, Capacitance-voltage.