Graphene-Silicon Solar Cells Characterization by means of Impedance spectroscopy

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The hardest challenge in semiconductor device characterization consists in the understanding of the device internal physics and working principles by accessing only external connections. Depending on the specific type of the considered device, several and different physical parameters can be investigated. Many of them depend on the interfaces between different materials, which are the preferential location of lattice defects. The double objective is (i) to isolate the contribution of each interface from the overall electrical behavior and (ii) to detect and characterize interface defects. Impedance spectroscopy (IS) is one of the most assessed frequency domain technique for decoupling the different physical processes existing at the various interfaces in the solar cell. This electrical characterization is a non-destructive technique that can be used in dark or in illumination condition if the considered device is photosensitive. This method permits the complete device characterization in the established working condition by differentiating the existing physical phenomena with different time constants. Adopting this technique, it is possible to validate a new front contact technology for Graphene based solar cells. This new typology is characterized using impedance spectroscopy and it is compared to typical gold contact technology. Impedance data are analyzed through equivalent circuit representation in terms of lumped parameters describing the overall impedance in all the range of frequency and DC bias considered in the experimental measurements. Using this approach, capacitance-voltage of the considered Graphene/Silicon solar cell is found and the barrier height forming at the interface Graphene/Silicon is extracted.