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A Three-Dimensional TLM Simulation Method for Thermal Effect in PV-Solar Cells

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Abstract : Temperature rising is a negative factor in almost all systems. It could cause by self heating or ambient temperature. In solar photovoltaic cells this temperature rising affects on the behavior of cells. The ability of a PV module to withstand the effects of periodic hot-spot heating that occurs when cells are operated under reverse biased conditions is closely related to the properties of the cell semi-conductor material. In addition, the thermal effect also influences the estimation of the maximum power point (MPP) and electrical parameters for the PV modules, such as maximum output power, maximum conversion efficiency, internal efficiency, reliability, and lifetime. The cells junction temperature is a critical parameter that significantly affects the electrical characteristics of PV modules. For practical applications of PV modules, it is very important to accurately estimate the junction temperature of PV modules and analyze the thermal characteristics of the PV modules. Once the temperature variation is taken into account, we can then acquire a more accurate MPP for the PV modules, and the maximum utilization efficiency of the PV modules can also be further achieved. In this paper, the three-Dimensional Transmission Line Matrix (3D-TLM) method was used to map the surface temperature distribution of solar cells while in the reverse bias mode. It was observed that some cells exhibited an inhomogeneity of the surface temperature resulting in localized heating (hot-spot). This hot-spot heating causes irreversible destruction of the solar cell structure. Hot spots can have a deleterious impact on the total solar modules if individual solar cells are heated. So, the results show clearly that the solar cells are capable of self-generating considerable amounts of heat that should be dissipated very quickly to increase PV module's lifetime.

Keywords : thermal effect, conduction, heat dissipation, thermal conductivity, solar cell, PV module, nodes, 3D-TLM
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