PHOTOCONVERSION IN POLYCRYSTALLINE SILICON. THE THEORETICAL MODEL

A.V. Sachenko, V.G. Litovchenko, A.P. Gorban, V.P. Kostyl'ov

Institute of Semiconductor Physics,
Nat. Acad. Sci. of Ukraine
(*45, Nauky Prosp., Kyiv 03028, Ukraine*)

S u m m a r y

We advance a three-dimensional model for photoconversion in polycrystalline silicon solar cells. Recombination both in the grain bulk and at grain boundaries is taken into account. A special case of parallelepiped-form grains is analyzed. We have obtained the theoretical expressions for spectral dependences of both short-circuit current and open-circuit voltage averaged over the grain area. It is shown that the main effect of recombination at grain boundaries can be described by the introduction of the effective diffusion length that equals to the characteristic length for a decrease of the excess electron-hole pair concentration along the incident light. We discuss the obtained dependences of the effective diffucion length on bulk diffusion length, grain size, and effective recombination rate at grain boundaries. The expression for a short-circuit current (under AM0 condition) averaged over the polycrystalline silicon solar cell (SC) area is obtained, and criteria for a practical equality of the above current to that in a single- crystalline silicon SC are found.