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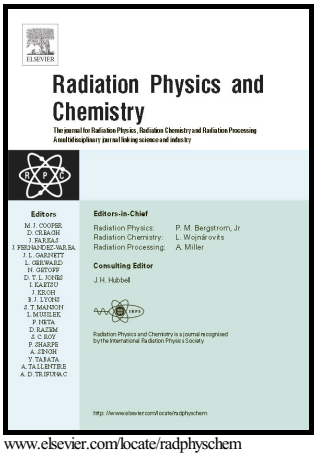

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Effects of ionizing radiation on the properties of mono-crystalline Si solar cells

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Abstract

Mono-crystalline Si solar cells were irradiated by cLINAC with electrons of 8 MeV and Bremsstrahlung photons obtained from electrons of 18 MeV. Systematic dose experiments were conducted with both irradiation types. The current-voltage, capacitance-voltage, conductance-voltage and external quantum efficiency analysis were carried out to investigate the overall effect of radiation on the crystalline Si solar cells. From these measurements, we summarized short-circuit currents, open-circuit voltage, fill factor and efficiency of prepared samples with respect to total applied dose and radiation types. All systematic experiments, measurements and calculations clearly indicate that solar cells are very sensitive to irradiation and nearly all parameters are seem to be decreased with respect to applied dose, regardless of radiation types. Moreover, overall efficiency of the solar cells are degraded by ∼15 % due to the irradiation which requires more attention for radiation protection of photovoltaic devices in the radiation harsh environments.

Keywords: `solar cell, LINAC, electron beam, photon beam, irradiation`
2017 MSC: 00-01, 99-00

1. Introduction

Solar cells (SCs) are the prominent renewable power sources converting lights to an electrical energy. Due to the its advantageous [1], mono-crystalline Si wafers are used in commercial SCs [2]. Recent studies showed that semiconductors are very sensitive to irradiation and they are very prone to changes in their optical and electrical properties [3, 4]. The charged particles and high energy photons may produce very large number of lattice defects and ionization effects in semiconductor crystals [5]. Since these defects in crystals limit transport properties and lifetime of minority charge carriers, electrical properties of SCs degrades significantly [6]. The main results of these defects are the new energy levels in semiconductor materials. These irradiation induced energy levels act as trap-energy levels. Minority carrier recombination centers cause coupling of electrons and holes in SCs by absorption of light. Since the minority charge carriers in base layer of p-n junction are reduced, the overall performance of SCs are also deteriorated. On the other hand, trapping of majority charge carriers by the new energy levels give rise to problems in electrical conductivity of material [7]. As a result, electrical conductivity of SCs exposed to radiation is decreased and turned into highly resistant structure. Since SCs are employed in space applications consisting of highly energetic electrons and photons, a very large number of attempts have been performed to discover the effects of radiation on the properties of SCs.

High energy photons [8, 9, 10, 11, 12, 13], neu-

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