Impact of Luminescent Coupling on the Degradation by Radiation of GaInP/GaAs solar cells

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Abstract:

III-V multijunction solar cells constitute the state of the art in space photovoltaics due to their high efficiency and radiation resistance. These III-V multijunction architectures incorporate direct bandgap materials which exhibit optoelectronic phenomena such as luminescent coupling (LC) that can positively affect solar cell performance.

Space environment imposes important challenges that need to be accounted for when designing a solar cell, since one ought to pay close attention to the damage by radiation incurred in the device. In typical GaInP/GaAs/Ge triple junction and GaInP/GaAs dual junction solar cells, the degradation of the most sensitive subcell, i.e. the GaAs subcell, has been extensively studied for different configurations (front homojunction, rear heterojunction, etc.) with and without the inclusion of photon recycling and as a function of charged particles fluence [1], [2].

In this work, we go one step beyond to study the degradation of the GaInP/GaAs dual junction designs when considering LC. Furthermore, the impact on solar cell performance of the reduction in quasi-Fermi level splitting because of particle radiation, from both a lifetime reduction and an increase in surface recombinations, is also calculated. To this end, we have implemented a rigorous optical model based on the scattering matrix formalism [3] and included it in the drift-diffusion Silvaco Atlas simulator, which allows us to effectively model LC and its effects on the endurance against radiation of the dual junction solar cell operation. As a preliminary result, Figure 1 shows that LC allows a higher efficiency for any proton fluence while the optimum GaAs subcell thickness decreases when proton fluence increases.

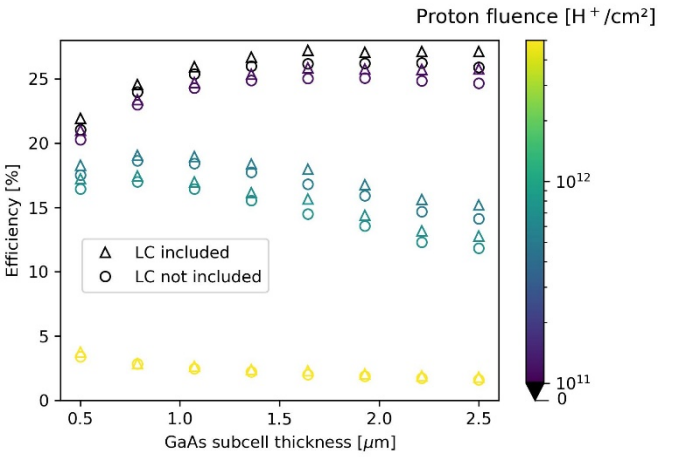

Figure 1. Efficiencies computed for a GaInP/GaAs dual junction solar cell as a function of GaAs subcell thickness when including (triangles) or ignoring (circles) LC for increasing proton fluence of 1 MeV.

Conflicts of Interest

The authors declare no conflict of interest.

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