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Assessment of GaAs, InP, and GaInP/GaAs/Ge solar cells performance in different radiation environments

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Abstract. Degradation of solar cell performance due to radiation within different space environments is an important effect to assess when designing the power subsystems. The behavior of the solar cell in a radiation environment can be described in terms of the changes of the device engineering output parameters. As the compound solar cells based on III-V materials have received much attention recently, the present work studies the power degradation of GaAs, InP, and GaInP/GaAs/Ge solar cells due to proton irradiation for different orbital trajectories.

Keywords. GaAs, InP, GaInP/GaAs/Ge, solar cell, Displacement Damage Dose, orbital trajectory, MULASSIS, coverglass.

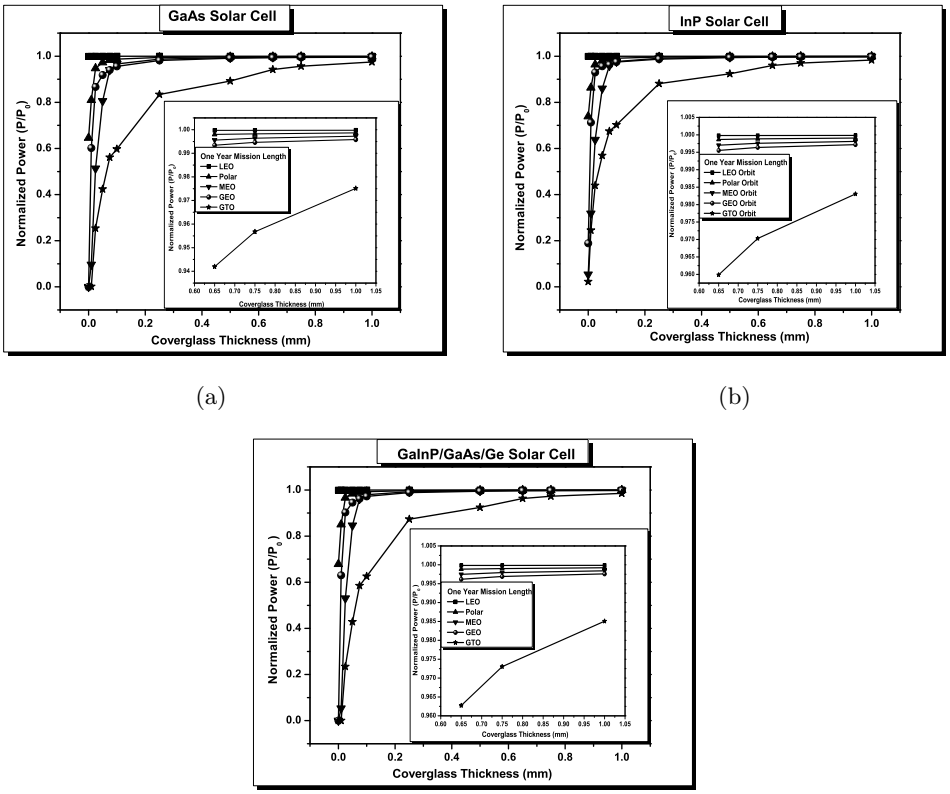
1. Introduction

The End-Of-Life (EOL) of space solar cell is considered a key parameter for array designers and is essential in planning for and exciting satellite missions. The EOL performance depends on the degradation that the cell undergoes due to exposure to a radiation environment. The present work studies the power degradation of GaAs, InP, and GaInP/GaAs/Ge solar cells due to proton irradiation for different orbital trajectories. The power degradation is described as a function of the coverglass shielding thickness. The slowed down spectra emerging from the shielding material is obtained using the MULASSIS code [Truscott et al., 2004] and the End-Of-Life solar cell performance is evaluated using the Displacement Damage Dose method [Messenger et al., 2001]. The inclination, perigee and apogee height of the representative orbits are summarized in table (1). Figure 1 (a, b, and c) plots the normalized power of the GaAs, InP and GaInP/GaAs/Ge solar cells as a function of the coverglass thickness along different five orbital trajectories for one year mission length respectively. It becomes quite clear that the solar cell power degradation is found to be sensitive to the details of the trajectory

Table 1. The inclination, perigee, and apogee of the representative orbits

Orbit	Inclination	Orbital perigee	Orbital apogee
LEO	28.4^0	597 km	618 km
Polar	98.5^0	724.7 km	839.3 km
MEO	56.2^0	19988.6 km	20375 km
GEO	0.0405^0	35774.7 km	35797.8 km
GTO	18.0115^0	338.5 km	34536.5 km

that a given spacecraft follows through the radiation sources. The figure shows that the power degradation of the different kinds of solar cells with no coverglass in a low inclination low altitude orbit is considered negligible in comparable to its correspondences along other orbital trajectories. For MEO, GEO, and GTO orbits, the power of unprotected solar cells is reduced to be zero and considered effectively dead. In addition, the figure presents that the power degradation of the different kinds of solar cells have their lowest values along the LEO orbit and have their highest value along the GTO orbit for all coverglass thicknesses. This refers to the fact that a spacecraft in a low inclination low altitude orbit is completely shielded from the transient solar protons and is exposed to relatively low fluence level of trapped proton fluences [Samwel et al. 2006]. Whereas, The GTO cuts across the inner and outer Van Allen belts, and have more exposure to the solar protons due to their high apogee altitude.



(a) (b)

(c)

Figure 1. Normalized power as a function of the shielding thickness for (a) GaAs (b) InP, and (c) GaInP/GaAs/Ge solar cells during one year mission length for different orbital trajectories

2. Conclusion

- The solar cell power degradation is found to be sensitive to the details of the trajectory that a given spacecraft follows through the radiation source.
- Increasing the coverglass thickness, reduces the power degradation of the solar cell.
- The power degradation of GaAs, InP, and GaInP/GaAs/Ge solar cells in a low incli-

nation, low altitude orbit (LEO) with and without coverglass is considered negligible in comparable to the other orbital trajectories.
- The Power degradation of GaAs, InP, and GaInP/GaAs/Ge solar cells is greatest at Geo-transfer orbit (GTO).

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