SPACE POWER SYMPOSIUM (C3)
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STATE OF THE ART PHOTOVOLTAIC ASSEMBLIES RELIABILITY ISSUES: CHARACTERIZATION AND QUALIFICATION ACTIVITIES FOR CONFIDENCE BUILDING

Abstract

Since a decade the number of solar arrays powered by solar cells belonging to III/V compounds has continuously grown and up to now the majority of the recently launched spacecrafts relies solely on this technology as primary power source. Meanwhile a certain number of in orbit failures, likely related to the electrical part of this kind of solar generators, have been detected, questioning the initial approach to consider applicable the same reliability figures used for the Si based arrays and derived from a more than 40 years flight heritage. As a matter of fact this is not completely applicable to GaAs based solar arrays because of important technology differences. These are for example related to the need of individual by-pass cell protection or micro crack propagation behaviour. Furthermore also well known environmental issues, like the UV transmittance induced losses, have to be carefully evaluated over exposure time and operational temperature mainly because of the different GaAs multijunction cell limitation principle. The present paper has the purpose to present a comprehensive approach to a wide spread of reliability related issues starting from the by-pass protection diodes (i.e. different technologies and principles), through various interface problems that could impact the solar generator active surfaces, reducing power performances. We will first present an overview of by pass protection devices (external silicon, integral and monolithic) in terms of characterization and qualification results, with special emphasis on the accelerated life test with or without the contemporary presence of illumination. Then we will describe how this approach can be extended to solar cells and networks and what are the risks of over testing associated

with extreme life acceleration (e.g. hot soak and thermal shocks in controlled atmosphere). Furthermore extensive UV test at solar cell assembly level (up to 5000 equivalent sun hours and 250C) has been performed and different results, depending on total exposure time and specimen temperatures, have been found, allowing a more precise extrapolation of loss factors over lifetime. Finally also the effects of the ion thruster created environment and micro meteorites and orbital debris (M/OD) impacts will be presented. More than assessing the overall damage, the most important task is to quantify the functional impacts and the residual resistance to fatigue stress. All these results will be merged to give a complete picture of the reliability scenario of the state of art photovoltaic assemblies and to provide risk mitigation suggestions.