

Individual SolAero ZTJ solar cells were bonded to a Kapton film substrate using three different silicones/PSAs to evaluate the bonding procedures. The bonded coupons were then subjected to repeat thermal cycling to demonstrate the robustness of the cell-to-Kapton bond. Thermal cycling testing is described in



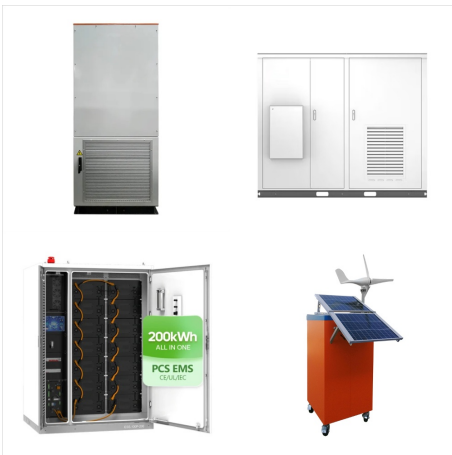
ZTJ Space Solar Cell is the 3rd Generation Triple-Junction solar cell for space application. Part of ZTJ family of solar cells optimized for all space missions. Up to 30.2% Minimum Average BOL Efficiency. About 1000 kW of ZTJ Family ???



Our latest generation solar cells and CICs are the highest efficiency commercially available products in the industry. Highest efficiency space solar cells and CICs ??? up to 34%; Cell areas of up to 81.5-cm<sup>2</sup> (custom sizes can be provided) ??? ???



Space Solar Cells offer high efficiencies, starting from the 28% class and ending in the high-end cell class of 32%. All solar cells include the latest triple and quadruple junction technology, where III-V layers are grown on a Germanium substrate and the whole product range benefits from many years' experience on the space market.



Emcore's latest generation InGaP/InGaAs/Ge ZTJ triple-junction space-grade high-efficiency solar cells have been in volume production since 2009, with over 300,000 flight cells produced to power more than 35 separate satellites. The ZTJ cells, CICs (Coverglass-Interconnected-Cell) and solar panels have also been characterized and qualified to both the AIAA-S-111 and AIAA-S-112 ???



4-junction n-on-p solar cell on germanium substrate; Superior radiation hardness and temperature performance compared to other Germanium based solar cells; 30.0% Minimum Average Efficiency for a typical GEO Telecom Mission, Z4J produces ~7% greater EOL power than ZTJ; Fully qualified to the AIAA-S111-2014 Qualification and Characterization



The cells (9 strings of 18 per panel for a total of 162 cells per observatory) are EMCORE's InGaP/InGaAs/Ge ZTJ triple-junction space-grade solar cells. These cells have an average conversion



\$10 Million Award Will Power Four Spacecraft Utilizing EMCORE's Highest Efficiency ZTJ Solar Cells. ALBUQUERQUE, NM -- (MARKET WIRE) -- 01/11/11 -- EMCORE Corporation (NASDAQ: EMKR), a leading provider of compound semiconductor-based components and subsystems for the fiber optic and solar power markets announced today that ???



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Emcore's ZTJ space solar cell features and characteristics: Lowest solar cell mass of 84mg/cm<sup>2</sup>. Third generation triple-junction (ZTJ) InGaP/InGaAs/Ge Solar Cells with n-on-p polarity on 140um Uniform Thickness Substrate. Space-qualified with proven flight heritage. Radiation resistance with P/Po = 0.90 @ 1-MeV, 5E14 e-/cm<sup>2</sup> fluence



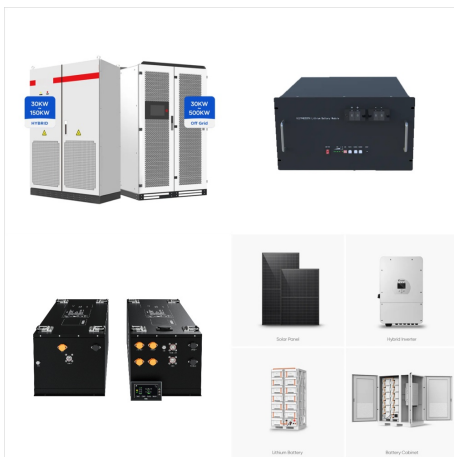
The ZTJ Plus from Rocket Lab is a Satellite Solar Cell with an efficiency of 29.4 % at maximum power point. This triple junction solar cell has an open circuit voltage of 2.69 V and a short-circuit current density of 17.11 mA/cm<sup>2</sup>. The solar cell features an n-on-p solar cell lattice matched on a germanium substrate and is qualified and



features ??? Inverted metamorphic n-on-p solar cell  
 ??? Solar cell mass of 49mg/cm<sup>2</sup> which represents a 42% reduction as compared to the ZTJ solar cell  
 ??? Radiation hardened design @ 1-MeV, 1E15 e-/cm<sup>2</sup> fluence P/Po = 0.87 (ECSS post-radiation annealing) ??? Compatible with corner-mounted silicon bypass diode for individual cell reverse bias protection



ZTJ Space Solar Cell is the 3rd Generation Triple-Junction solar cell for space application. Part of ZTJ family of solar cells optimized for all space missions. Up to 30.2% Minimum Average BOL Efficiency. About 1000 kW of ZTJ Family Flight Cells manufactured to date. Powering more than 200 separate satellites.



Our latest generation solar cells and CICs are the highest efficiency commercially available products in the industry. Highest efficiency space solar cells and CICs ??? up to 34%; Cell areas of up to 81.5-cm<sup>2</sup> (custom sizes can be provided) ??? Space-qualified cell technologies: ZTJ, ZTJ+, ZTJ-?(C), Z4J, Z4J+ and IMM



Abstract: We report the results to date of qualification testing of Emcore's sixth generation III-V multi-junction solar cell - the ZTJ GaInP<sub>2</sub>/Ga(In)As/Ge cell. The ZTJ cell is currently undergoing space qualification per the requirements of the American Institute of Aeronautics and Astronautics (AIAA) S-111-2005 standard. The S-111 document



Typical ZTJ Illuminated I-V Plot 2Lowest solar cell mass of 84 mg/cm 3rd Generation Triple-Junction (ZTJ) InGaP/InGaAs/Ge Solar Cells with n-on-p Polarity on 140-um Uniform Thickness Substrate Fully space-qualified with proven flight heritage 2Excellent radiation resistance with  $P/P_o = 0.90$  @ 1-MeV,  $5E14$  e/cm<sup>2</sup> fluence Designed to accept



ZTJ-(C) Space Solar Cell is a triple-junction solar cell optimized for LEO environment. Part of ZTJ family of solar cells optimized for all space missions. Up to 30.2% Minimum Average BOL Efficiency. About 1000 kW of ZTJ Family Flight Cells manufactured to date. Powering more than 200 separate satellites.



A number of SolAero Inverted Metamorphic Multijunction (IMM) and ZTJ solar cells, both bare and CICs, were subjected to ever increasing displacement 4-point bend testing. Following each flexure, the cells were characterized by current-voltage and electroluminescence measurements. The data demonstrated that on average IMM CICs can be displaced 65% further than ZTJ ???



spacesystems@rocketlabusa rocketlabusa features  
 ??? 4-junction n-on-p solar cell on germanium  
 substrate ??? Radiation hardened design with  $P/P_o = 0.90$  @ 1-MeV electron,  $1E15 \text{ e/cm}^2$  fluence ???  
 For a typical GEO Telecom Mission, Z4J produces  
 ~7% greater EOL power than ZTJ (1-MeV electron,  
 $1E15 \text{ e/cm}^2$  @  $55^\circ\text{C}$ )



spacesystems@rocketlabusa rocketlabusa features  
 ??? Triple-Junction, n-on-p solar cell lattice matched  
 on germanium substrate ??? Radiation hardened  
 design @1-MeV,  $1E15 \text{ e/cm}^2$  fluence  $P/P_o = 0.87$   
 (ECSS post-radiation annealing) ??? Compatible  
 with corner-mounted silicon bypass diode for  
 individual cell reverse bias protection



Abstract: The Emcore One-per-wafer ZTJ solar cell,  
 with a cell area of approximately  $60 \text{ cm}^2$ , is based  
 on the 29.5% efficiency ZTJ triple-junction  
 structure. The performance of this cell has been  
 enhanced via grid design improvements, resulting in  
 a 0.3% absolute efficiency increase. To confirm  
 electrical performance and investigate reliability with  
 respect to the grid metal and form ???



This paper outlines the recent progress SolAero Technology Corp. has made in the development of two advanced III-V multijunction solar cell technologies for space applications. The first is the radiation hard 32% efficient IMM-??, and the second is the radiation hard 30% efficient four-junction Z4J. The performance and cost metrics of each device is compared to the state-of-the-???



The Emcore One-per-wafer ZTJ solar cell, with a cell area of approximately 60cm<sup>2</sup>, is based on the 29.5% efficiency ZTJ triple-junction structure. The performance of this cell has been enhanced via



This solar cell known as the ZTJM is a companion cell to the 30% class GaInP<sub>2</sub>/Ga(In)As/Ge ZTJ solar cell. The ZTJ cell is characterized by a beginning of life (BOL) maximum power point efficiency



ZTJ-?(C) Space Solar Cell is a triple-junction solar cell optimized for LEO environment. Part of ZTJ family of solar cells optimized for all space missions. Up to 30.2% Minimum Average BOL Efficiency. About 1000 kW of ZTJ Family ???



The ZTJ - Ohm from Rocket Lab is a Satellite Solar Cell with a BOL efficiency of 32 % at maximum power point. This solar cell has an open circuit voltage of 2.73 V and current density of 16.8 mA/cm<sup>2</sup> at maximum power. It has a voltage of 2.43 V at maximum power and a short-circuit current density of 17.41 mA/cm<sup>2</sup>.



spacesystems@rocketlabusa rocketlabusa features  
 ??? 4-junction n-on-p solar cell on germanium substrate ??? Radiation hardened design with P/Po = 0.90 31.3% @ 1-MeV electron, 1E15 e/cm<sup>2</sup> fluence ??? For a typical GEO Telecom Mission, Z4J+ produces 12% greater EOL power than ZTJ