DEVELOPMENT OF AN ULTRAFLEX-BASED THIN FILM SOLAR ARRAY FOR SPACE APPLICATIONS

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As flexible thin film photovoltaic (FTFPV) cell technology is developed for space applications, integration into a viable solar array structure that optimizes the attributes of this cell technology is critical. An advanced version of ABLE's UltraFlex solar array platform represents a near-term, low-risk approach to demonstrating outstanding array performance with the implementation of FTFPV technology. Recent studies indicate that an advanced UltraFlex solar array populated with 15% efficient thin film cells can achieve over 200 W/kg EOL. An overview on the status of hardware development and the future potential of this technology is presented.

REVIEW ABSTRACT

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As flexible thin film photovoltaic (FTFPV) cell technology is developed for space applications, integration into a solar array structure that optimizes the attributes of this cell technology is critical. An advanced version of AEC-Able's UltraFlex solar array platform represents a near-term, low-risk approach to demonstrating outstanding array performance with the implementation of FTFPV technology. The UltraFlex array provides a viable platform to exploit the benefits of FTFPV technologies because its structural areal mass is over 3.5X lighter than a classical rigid panel array.

This paper will present the results of a hardware development program initiated under NASA's Small Business Innovation Research (SBIR) Program to develop a solar array design that can incorporate the attributes thin film solar cell technology into a space-qualifiable solar array to support a variety of space flight missions. Figures 1 and 2 show some of the hardware development conducted to-date involving the integration of the thin film cell technology into the array structure. The photos show FTFPV module development, cell-to-cell interconnections, and laydown concepts. Studies from the SBIR Phase 1 and Phase 2 programs have indicated that an advanced UltraFlex solar array system, populated with 15% efficient FTFPV solar cells, can produce over 200 W/kg end-of-life specific power, maintain a low stowed volume, and potentially provide significant cost reduction if a monolithic interconnection scheme is implemented. Table I gives one example of the array performance parameters for one specific design case. The results of these trade studies and the sensitivity of various aspects of FTFPV cell development to overall array performance will be presented.

The overall goal of the program and its application to various space missions will be summarized, as will performance predictions, risk mitigation activities, and recommendations for further development. The paper will also address the various issues associated with the integration of this advanced cell technology into a previously space-qualified (using crystalline cell technology) solar array structure, discuss modifications that have been made to the array design and provide a status on the hardware development that has been completed.

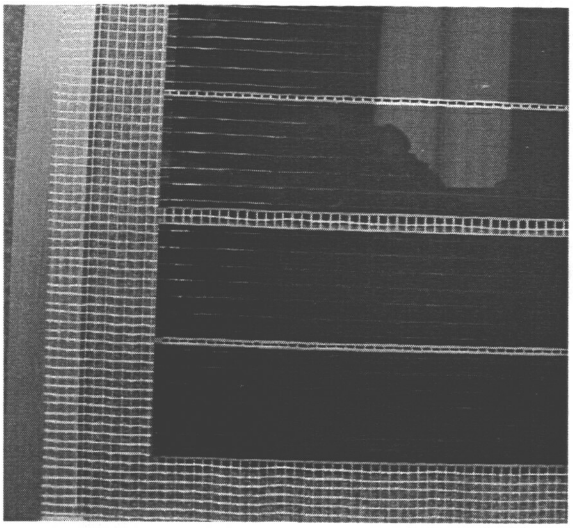

Figure 1. Interconnected thin film solar cell technology attached to UltraFlex gore substrate.

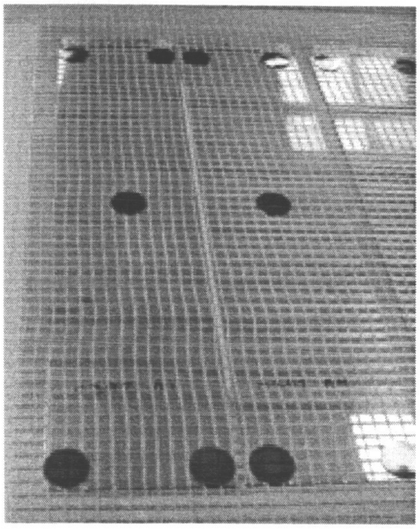

Figure 2. UltraFlex gore substrate viewed from back showing attachment of thin-film solar cells to the gore substrate.

	BOL			EOL		
	EQUINOX	SUMMER SOLSTICE	WINTER SOLSTICE	EQUINOX	SUMMER SOLSTICE	WINTER SOLSTICE
Wiring Resistance to Connector, string (Ohms):						
Nominal String Voltage:	265.94	270.61	262.84	251.60	253.99	246.64
Nominal String Current:	0.4442 A	0.4291 A	0.4600 A	0.3912 A	0.3876 A	0.4155 A
Nominal String Power:	118.12 W	116.11 W	120.89 W	98.43 W	98.43 W	102.47 W
Diode & Wiring Voltage Drop to Connector (string):	1.412	1.387	1.437	1.327	1.321	1.366
Net String Voltage:	**264.53 V**	**269.22 V**	**261.40 V**	**250.27 V**	**252.67 V**	**245.27 V**
Net Power per String:	117.50 W	115.51 W	120.23 W	97.91 W	97.92 W	101.90 W
Net Section Power @ Mission Distance	**12219.70 W**	**12013.21 W**	**12504.22 W**	**10182.27 W**	**10183.92 W**	**10597.67 W**
Net Section Power @ Mission Distance	12219.70 W	12013.21 W	12504.22 W	10182.27 W	10183.92 W	10597.67 W
Specific Power (W/kg):	255.15	250.84	261.09	**212.61**	212.64	221.28
W/m^2	155.20	152.57	158.81	129.32	129.34	134.60

Table I. Preliminary results showing array performance using 15% thin film solar cell technology.