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Ultra-Flexible Photo-voltaic (PV) Phase I SBIR

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A181-067-1510

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
PowerFilm, Inc.
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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14. ABSTRACT
The project consisted of taking SunPower solar cells, cutting them down to a size small enough to produce a tile like structure, making electrical contact to the back side of these cells then interconnecting the cells together to produce a photovoltatic array. The Phase I contract was broken down into 5 parts a summary of each these parts is listed below.

15. SUBJECT TERMS
Solar, Amorphous Silicon, Ultra-Flexible, Photo-voltaic

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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SUMMARY REPORT PROFILE

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28 June 2019

GRANT PM, ARMY SBIR OFFICE PERMISSION

All award winners must submit summary report at the end of their Phase I and any subsequent Phase II project. The summary report is unclassified, non-sensitive and non-proprietary and should not exceed 700 words. A photo is required. It is intended for public viewing on the Army SBIR/STTR Small Business area. This summary report is in addition to the required final technical report and should require minimal work because most of this information is required in the final technical report. By submitting this report, I give permission to PM, Army SBIR to publicly post this report.

REPORT DETAILS

Status	PM Approved	
Type	Phase I Final	
Title	Ultra-flexible high efficiency photovoltaics - c-Si	
Contract Number	W911QY-18-P-0174	
Proposal Number	A181-067-1510	If you would like to view the proposal coversheet that was submitted for this particular contract click this link. Proposal Coversheet
Topic Number	A18-067	
PA Clearance Number		

Description and Anticipated Benefits

The modern Military has an ever-increasing need for power, in particular light-weight portable power with high power densities and decreased deployed foot print. Currently, photovoltaic packable panels are made from light weight Amorphous Silicon or carbon fiber backed crystalline silicon. The amorphous silicon technology has a low stowed volume and is highly durable, but has low power conversion efficiency per unit of deployed area. The carbon fiber backed crystalline has a high conversion efficiency per unit of deployed area, but is breakable and has a large stowed volume. The solution to this is to take the benefits of the two different technologies and combine them to produce a solar fabric that has high power conversion and ultra-flexibility leading to increased durability. To achieve the two greatest challenges of this project, compound curve tolerance and high efficiency, PowerFilm proposed the following solution; to make an ultra-flexible photovoltaic sheet on a flex substrate with tiles of high efficiency crystalline silicon.

This project consisted of taking SunPower solar cells, cutting them down to a size small enough to produce a tile like structure, making electrical contact to the back side of these cells then interconnecting the cells together to produce a photovoltaic array. The Phase I contract was broken down into 5 parts: flex circuit design, cell cutting, solder stencil design, array assembly, and array encapsulation. The tile like structures are integrated into fabric and interconnected with extremely flexible wires allowing for thousands of bend cycles to 180 degrees and protecting the cells from cracking or breakage leading to a very robust high efficiency solar fabric.

DoD customers for this product would include: dismounted Soldiers, remote sensors, remote radio installations, mounted Soldiers and vehicles. Non-DoD customers include hikers/backpackers, border patrol, remote exploration crews, mountaineers, county sheriffs, and first responders - to name a few.

This technology is the bridge between the thin lightweight amorphous technology and the extremely expensive GaAs technology. This technology boosts the electrical conversion efficiency of the fielded solar panel from 5% to 15% without increasing the cost to the user. Both DoD and Non-DoD customers who are looking for more power in a smaller area at a reduced cost will benefit from this technology development.

Additional Comments

Flex Circuit Design

The PCB artwork that was designed under this contract worked very well, and for this type of a design - no further work is needed. Matching the back-side cell traces to the PCB, without having the original artwork from the cell manufacturer, was also completely figured out and no further work would be required on this task going forward.

Cell Cutting

This task was thought to be one of the easier tasks going into the contract, however what was discovered is that cutting a cell and keeping the performance high is no easy feat. In the end it required specialized cutting platen, a focused gaussian laser beam, and removal of the back-side metal on the solar cell. Ultimately, cell cuts were made with minimal degradation to the solar cell performance.

Stencil Design

This task was also considered a success; the stencil is the means to put down the solder paste to which bonds the cell to the PCB. There was concern that the alignment between the cell and the PCB would be super critical.

However, what PowerFilm found out was the cells would self-align to the traces on the board almost every time.

Array Assembly

Array assembly was also considered a success, everything from stringing together the cells, encapsulating, and mounting on fabric was pretty much standard operation here at PowerFilm

Array Encapsulation

Using the encapsulation materials that were designed for thin film amorphous products to build the highly flexible crystalline array worked flawlessly

Overall PowerFilm feels the Phase 1 SBIR Ultralight Weight Photovoltaic project was a huge success. This contract took a number of great ideas and put them into reality. PowerFilm feels that this technology could be the low cost, high performance, durable, light weight solar module of the future.

The current plan is to use phase 2 funding to increase the manufacturing capability of this technology. This involves interfacing with automated SMT (Surface Mount Technology), to produce tiles without manual labor. In addition, designing automation for automatic cell cutting, sorting, and testing to feed SMT assembly lines. Encapsulation of the tiles of cells and parallel and series arrangement of the arrays is currently a known implemented technology at PowerFilm.

Photograph Caption

1cm x 1cm cells mounted on Litelock Fabric showing compound bend

Photograph Image (Web)

Video or other document