Ultrasonic Technologies, Inc
UST = Ultimate Smart Tools

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In-Line Quality and Process Control in Solar and Fuel Cell Manufacturing

SBIR phase IIB, DE-SC0010117
Ultrasonic Technologies, Inc.
07/31/2017-09/30/2019

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Ultrasonic Technologies, Inc.

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Overview

Timeline

- SBIR Phase IIB Award, started 08/01/2017
- Projected End date: 09/30/2019 (2 months no cost extension)
- Project 85% complete

Budget

	FY 17 Costs	FY 18 Costs	Total Planned Funding
DOE Funded	493.3K	493.3K	986.6K
Project Cost Incurred To date	493.3K	317.3K	810.6

AMO MYPP Connection

3.3.2 Advanced Manufacturing for Clean Electric Power Generation

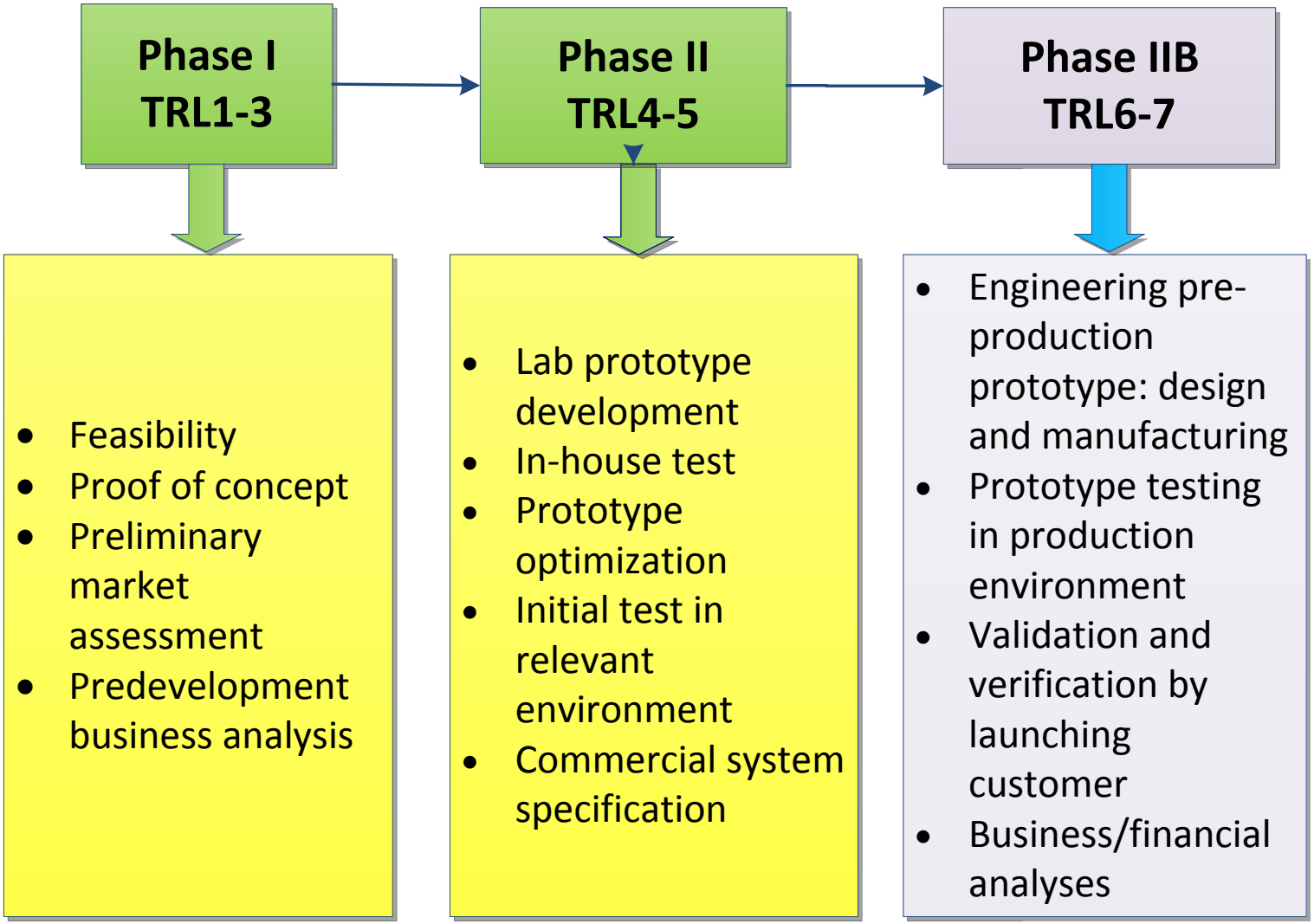
Barriers

The Key barrier of the Activation Station (AS) technology is to achieve full compatibility of the laboratory AS tool with production up-stream equipment in solar cell industry.

Partners

- Ultrasonic Technologies (Lead), developer of AS technology and AS tools;
- University of South Florida (FL) – analytical tools for crack inspection in solar cells and LT wafers
- Silfab Solar (WA) – solar module producer, site for validation
- TDK Electronics (Austria) – LT wafer user, material provider

SBIR Project Flowchart



Phase IIB Technical Objectives

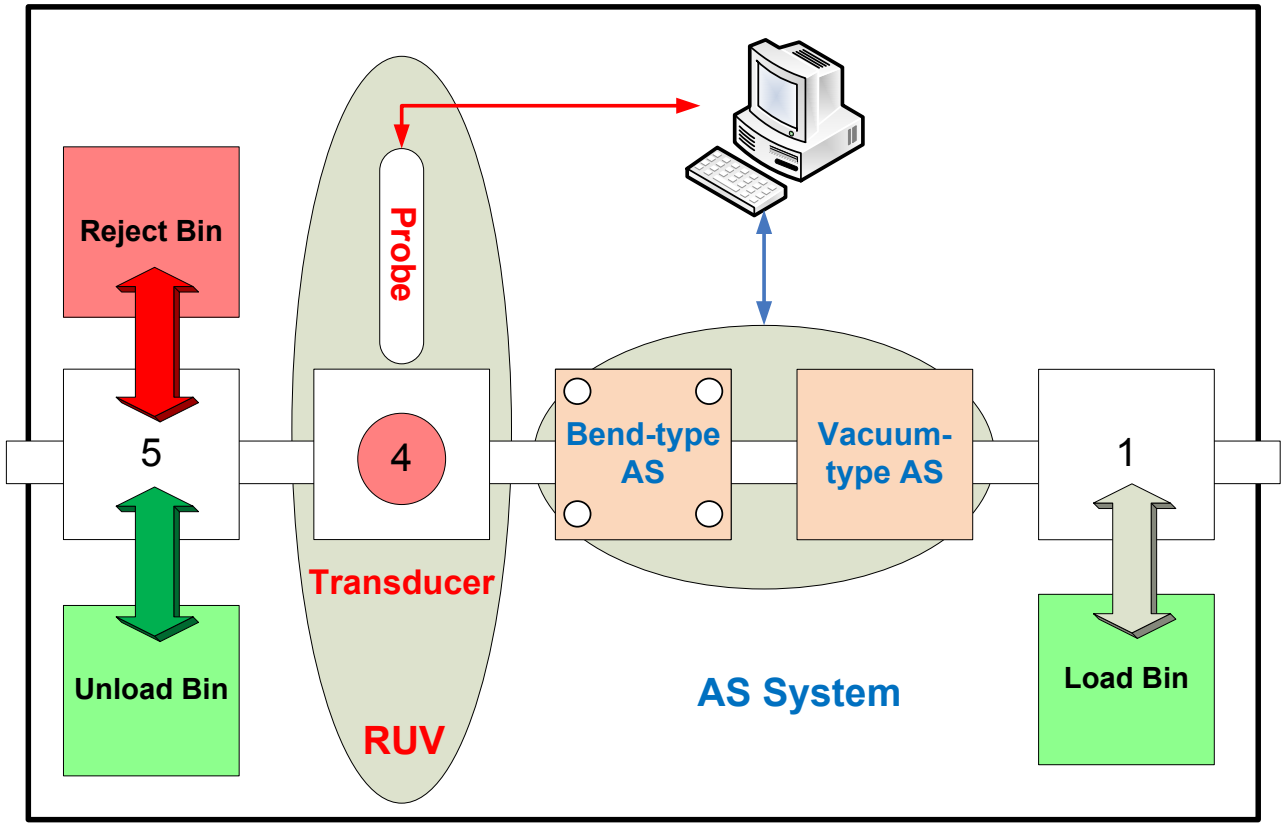
(O1) Upgrade AS tool hardware using Programmable Logic Controller technology to improve AS reliability, accuracy, and maintainability.

(O2) Upgrade AS tool operational software to allow handshaking with in-line commercial equipment.

(O3) Improve throughput and ensure AS applicability to different shapes and types of substrates.

(O4) Integrate AS tool in the front-end of solar module line, perform validation and verification using commercial solar cells.

Activation Station (AS) Technology

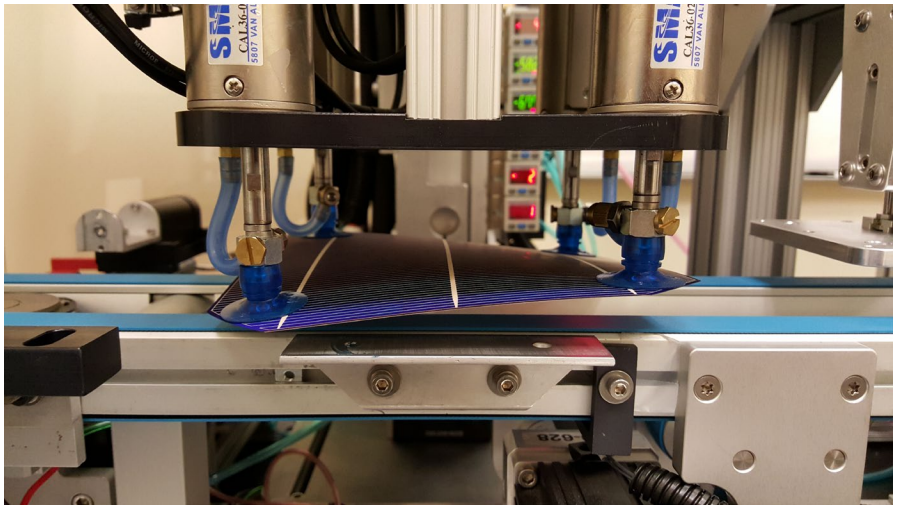


Layout of the AS system integrated with Resonance Ultrasonic Vibrations (RUV) for sub-mm length crack inspection in solar cells. AS technology was extended in this project to inspection of $LiTaO_3$ wafers for Surface Acoustic Wave sensors.

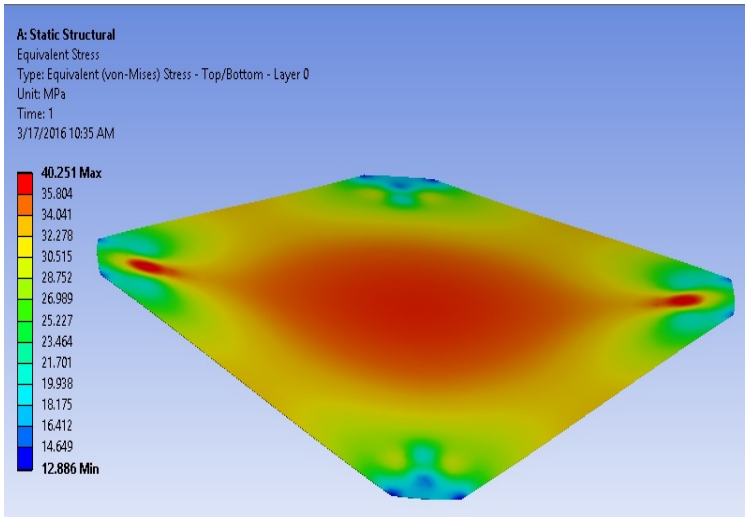
Technical Innovation(1)

The **technical approach** for in-line AS involves: (1) application of controlled mechanical stress profile to wafers or cells; (2) measurement of elastic deflection caused by applied stress, (3) elimination of mechanically unstable wafers/cells caused by seed cracks. Two types of AS system are designed and tested in Phase I and Phase II:

(a) Bend-type AS



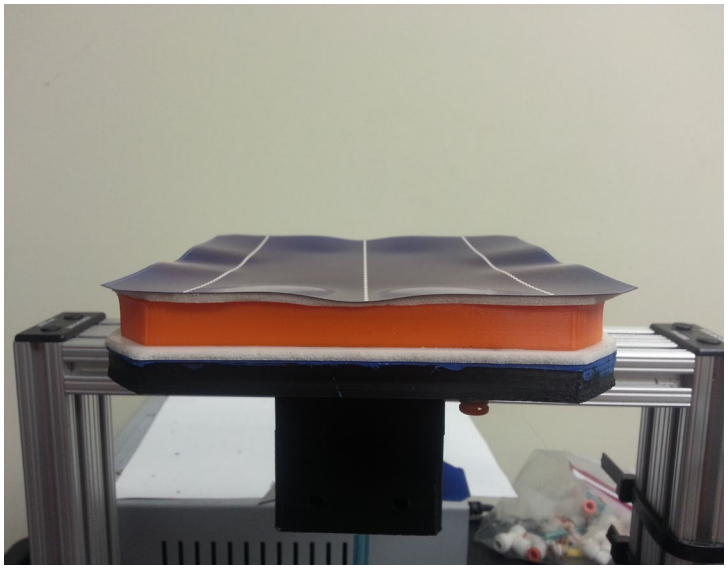
Laboratory prototype of the bend-type AS for in-line crack detection. AS provides controlled twist of wafer.



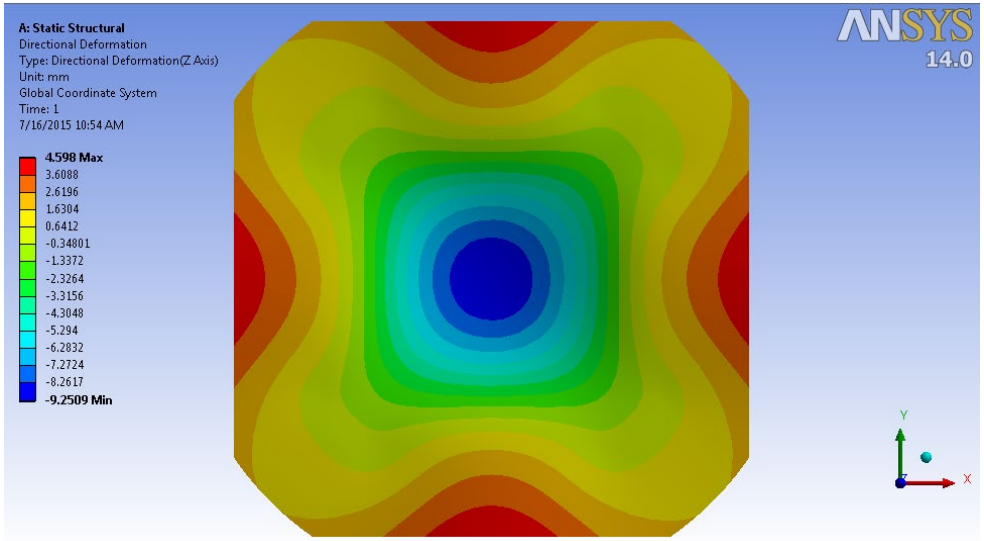
Finite Element Analysis of stress distribution when Si wafer is twisted with four vacuum cups at 12mm deflection.

Technical Approach (2)

(b) Vacuum-type AS



Solar cell deflection using vacuum-type AS (v-AS) to expose sub-mm length cracks.



Finite element analysis model of deflection profile in silicon solar wafer using v-AS quatrefoil chuck.

Results and Accomplishments (1)

1. "Prototype Integration with Production Tools" (Task 5): Ultrasonic collaborated with US-solar module manufacturer – Silfab Solar, Inc. (Bellingham WA). Silfab provided commercial grade solar cells, contributed with labor and production space for validation test.
2. "AS Testing in Production" (Task 6): Performed AS high volume test by integrating the RUV-AS automatic system with incoming ports of module line.
3. "AS system for $LiTaO_3$ (LT) wafers" (Task 7): Developed methodology, designed and manufactured a stand-alone AS system for $LiTaO_3$ (Lithium Tantalate) wafers. Performed high volume inspection of seed cracks in LT wafers. Jointly with TDK proved yield increase in LT production.

RUV-AS system in solar module production

Results and Accomplishments (2)

Required Future Work

To Complete Task 7: Customize and extend AS technology for quality control in $LiTaO_3$ (LT) and $LiNbO_3$ (LN) wafers in SAW sensor production:

1. Modify stand-alone AS system prototype hardware for application in production grade LT and LN wafers. May – June, 2019.
2. Modify and upgrade AS operational program to respond to fast delivery of negative vacuum pressure to the LT and LN wafers. June – August, 2019.
3. Test the AS system prototype on limited quantity of LT and LN production wafers. August – September, 2019.

Project Schedule Status

	Year 1				Year 2				Personnel
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	
Task 1: Prototype Specification									Ostapenko, Tarasov, Rodrigues
Task 2: Hardware upgrade									Rodrigues
Task 3: Software upgrade									Tarasov
Task 4: In-house AS certification									Ostapenko, Tarasov
Task 5: Prototype Integration with Production Tools									Ostapenko, Causey, Silfab Solar
Task 6: AS testing in Production Environment									Ostapenko, Tarasov, Causey, Silfab Solar
Task 7: AS technology for LiTaO3 wafers									Ostapenko Tarasov, Causey, TDK

Transition

- AS system by the end of this project will be a quality control unit for incoming solar cells and $LiTaO_3$ wafers.
- AS will be used in commercial turn-key lines for solar cell modules.
- AS will be also marketed as a stand-alone QC tool to develop and optimize process steps.
- We identified partners to bring AS system to commercial market in solar cells and $LiTaO_3$ wafers.