



Material and Device Analysis for Efficiency Improvement in Epitaxial Crystalline Solar Cells

**Cooperative Research and Development
Final Report**

CRADA Number: CRD-11-433

NREL Technical Contact: Bhushan Sopori

**NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC.**

This report is available at no cost from the National Renewable Energy
Laboratory (NREL) at www.nrel.gov/publications.

CRADA Report
NREL/TP-5200-61158
January 2014

Contract No. DE-AC36-08GO28308

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Available electronically at <http://www.osti.gov/bridge>

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: <mailto:reports@adonis.osti.gov>

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: <http://www.ntis.gov/help/ordermethods.aspx>

Cover Photos: (left to right) photo by Pat Corkery, NREL 16416, photo from SunEdison, NREL 17423, photo by Pat Corkery, NREL 16560, photo by Dennis Schroeder, NREL 17613, photo by Dean Armstrong, NREL 17436, photo by Pat Corkery, NREL 17721.



Printed on paper containing at least 50% wastepaper, including 10% post consumer waste.

Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA Number: CRD-11-433

CRADA Title: Material and Device Analysis for Efficiency Improvement in Epitaxial Crystalline Solar Cells

Parties to the Agreement: Crystal Solar

Joint Work Statement Funding Table Showing DOE Commitment:

Estimated Costs	NREL Shared Resources
Year 1	\$ 5,000.00
Year 2	\$ 00.00
Year 3	\$ 00.00
TOTALS	\$ 5,000.00

Abstract of CRADA Work:

Crystal Solar has a novel approach for producing low-cost, monocrystalline silicon wafers that are capable of yielding high-efficiency solar cells. The approach involves epitaxial growth of the substrate and a proprietary lift-off technology. Crystal Solar will send selected wafers and cells to NREL for characterization and analyses. NREL will apply a variety of techniques to help identify mechanism(s) that limit the cell efficiency and suggest suitable approaches for mitigation.

Summary of Research Results:

The work performed under this CRADA relates to characterization of defects and impurities in the Epiliftoff wafers produced by Crystal Solar. It was found that epitaxially grown thick silicon layers can have dislocations and stacking faults as the crystal defects. These defects significantly degrade the solar cell performance. To produce material for high efficiency solar cells, one must control the epi growth conditions to minimize crystal defects.

Subject Inventions Listing: None

Report Date: 12/6/13

Responsible Technical Contact at Alliance/NREL: Bhushan Sopori

This document contains NO confidential, protectable, or proprietary information.