NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Flexible CIGS Test and Evaluation

Cooperative Research and Development Final Report

CRADA Number: CRD-08-293

NREL Technical Contact: Michael Kempe

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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.

Parties to the Agreement: 3M Company

CRADA Number: CRD-08-293

CRADA Title: Flexible CIGS Test and Evaluation

Joint Work Statement Funding Table Showing DOE Commitment:

Estimated Costs	NREL Shared Resources
Year 1	$ 150,000.00
Year 2	$ 127,976.00
Year 3	$ 130,352.00
Year 4	$ 133,672.00
TOTALS	$ 542,000.00

Abstract of CRADA Work:

NREL will assist 3M in evaluating the application of 3M encapsulant materials on industry-supplied, flexible CIGS minimodules.

Mod 3: NREL is recognized as a world-leader and center of excellence for photovoltaic measurement, testing and research. As such, they have equipment capabilities and expertise needed to support this program. Specifically, this proposal will be taking advantage of NREL's outdoor module monitoring system and their indoor exposure chambers. Outdoor monitoring will be done for CIGS modules laminated with the 3M Ultra Barrier Topsheet samples. The module performance will be continuously monitored and tabulated to provide a baseline of data to support 1) decisions on what topsheet constructions perform best relatively; and, 2) a lifetime prediction model for our product.

Summary of Research Results:

Over the course of this 4 year project work was performed to evaluate the durability and functionality of 3M's ultrabarrier films. These films are intended to be used as moisture barriers for flexible thin film photovoltaic (PV) devices. To be relevant for the PV application, the water vapor transmission rate (WVTR) must be less than 10^{-4} g/m^2/day.

NREL testing included the exposure of test coupons and prototype modules outdoor at NREL as well as indoors using accelerated stress testing methods. Also of particular interest is the utilization and further development of NREL's electrical Ca water vapor transmission measurement methodology capable of measuring WVTRs as low as 10^{-6} g/m^2/day which is about 100X more sensitive than the best commercial equipment available. Over the course of this research project about 250 measurements were made providing statistically relevant data on the manufacturability of these barrier films. By the end of the project, barrier performance was pushing the limits of our measurement capability and inadequate WVTRs were rarely obtained.

Work was also conducted to develop a laminated frontsheet film containing the barrier layer. This consisted of a fluoropolymer frontsheet with a UV absorbing adhesive to both bond to, and to protect the moisture barrier film. Samples consisting of both adhesive only and of the complete barrier film were subjected to accelerated stress tests in a custom built chamber capable of exposing samples to 10 UV-suns irradiation at a well-controlled temperature. Typically samples were exposed to either 4 UV-suns or 10 UV-suns at a temperature of 85°C or 105°C. Using multiple stress levels allowed some extrapolation to the use environment to get an idea of the relevant durability of the materials. Multiple iterations of these accelerated stress tests yielded progressively more durable materials. Laminate frontsheet moisture barrier films were developed which did not yellow significantly over time, and for which the moisture barrier characteristics were retained under very high stress conditions.

Subject Inventions Listing:

No inventions were made my NREL under this agreement.

Report Date:

1/28/15

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