



# **Development of Abrasion-Resistant Coating for Solar Reflective Films**

**Cooperative Research and Development Final Report**

**CRADA Number: CRD-07-247**

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**CRADA Report**  
NREL/TP-5500-65117  
October 2015

Contract No. DE-AC36-08GO28308

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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:** SkyFuel, Inc.

**CRADA Number:** CRD-07-247

**CRADA Title:** Development of Abrasion-Resistant Coating for Solar Reflective Films

### **Joint Work Statement Funding Table Showing DOE Commitment:**

<b>Estimated Costs</b>	<b>NREL Shared Resources</b>
Mod 2	\$ 250,000.00
Mod 3	\$ 70,000.00
TOTALS	\$ 320,000.00

### **Abstract of CRADA Work:**

The purpose of this CRADA is to develop an abrasion-resistant coating, suitable for use on polymeric-based reflective films (e.g., the ReflecTech reflective film), that allows for improved scratch resistance and enables the use of aggressive cleaning techniques (e.g., direct contact methods like brushing) without damaging the specular reflectance properties of the reflective film.

### **Summary of Research Results:**

NREL and SkyFuel have collaborated for years and have jointly patented intellectual property that has resulted in a commercial solar polymer reflector known as ReflecTech<sup>®</sup> Mirror Film (RTMF). SkyFuel has had an exclusive license to pursue commercialization of RTMF, which has allowed them to market the flexible reflector directly as a standalone product as well as to develop parabolic trough designs specific to the material so that they can best take advantage of its qualities. The partnership between NREL and SkyFuel through this CRADA is viewed as a success story by both. Each stage of this process has been efficient, cooperative, and productive.

Under the auspices of this CRADA (#CRD-07-247), further improvements to RTMF have been achieved. SkyFuel has continued to work with several vendors to scale up from successfully prepared laboratory and pilot samples of abrasion resistant coated (ARC) RTMF to commercialize a new product known as ReflecTech<sup>®</sup> PLUS Mirror Film (RTMF+). We have also completed long term testing of pilot scale versions of RTMF to demonstrate maintenance of abrasion resistance, adhesion, and weatherability for lifetimes of ~35-40 years. Similar testing of production scale samples of RTMF+ was initiated during the final phases of the CRADA. Multi-

exposure results for RTMF+ were very promising. However, the full test matrix for the new construction and alternate vendors was not complete at the CRADA's end due to vendor delays and stoppages.

During early efforts within the CRADA, discussions resulted in the conception of ARC constructions ("An Improved Low-Cost Highly Weatherable Solar Reflector with High Abrasion Resistance" PCT/US11/50542 Filed: September 6, 2011). The ARC would provide scratch resistance to the overall stack. In addition, we have previously demonstrated the excellent weatherability of a particular ARC formulation/product developed by a preferred coating partner. Reflector constructions developed within the CRADA consist of a series of layers that have been selected to result in the features of UV resistance, outdoor weatherability, abrasion resistance, high mechanical stability (even under the extremes of an outdoor environment), high solar reflectance, and ease of manufacture in order to achieve low costs.

The ARC formulation that was tested at NREL adheres well to the top layer of RTMF. In early phases, laboratory and pilot scale samples were prepared by NREL. These had varying degrees of success in terms of adhesion, and the samples were not of sufficient quality for exposure testing. This process did, however, provide knowledge, insight, and new ideas about how to proceed with successful sample preparation. In the final phases, prototype advanced ARC samples that demonstrate requisite adhesion between the ARC and the intended substrate materials were prepared and optically and mechanically characterized. Samples were then subjected to appropriate exposure testing to demonstrate the abrasion resistance and weatherability of these new constructions. Verification and additional development was ongoing at the time of the CRADA's closure.

An additional outcome of the CRADA was the development of a battery of accelerated exposure test protocols and analytical characterization techniques that provide satisfactory durability verification. This includes exposure of samples at NREL's R&D100 award winning ultra-accelerated exposure system (UAWS). UAWS exposure allows the relative weatherability (targeted for 30+ years) associated with the various ARC products to be rapidly ascertained (~1 year). Accelerated exposure using NREL's Solar Simulator and ATLAS WeatherOmeter chambers is also performed to understand additional environmental influences. Several test instruments that quantify abrasion resistance have been used at NREL to qualify performance of the intended ARC coatings incorporated in the advanced reflector constructions.

**Subject Inventions Listing:**

International Application No. PCT/US2011/050542, filed June 9, 2011, entitled, "An improved low-cost highly-weatherable solar reflector with high abrasion resistance," and corresponding U.S. Application No. 14/342,731 filed on August 19, 2014.

**Report Date:** 17 July 2015

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