Fenestration Research at NREL
National Fenestration Rating Council
Baltimore, MD
March 26, 2019

Robert Tenent
Senior Scientist
robert.tenent@nrel.gov
NREL Fenestration Research Overview
NREL Program History

• Over 35 years of innovation supporting emerging fenestration technologies

• 2009 R&D 100 Award for reflective electrochromic technology

• 2010 Colorado Governor’s Award for High Impact Research

• 2011 NREL Excellence in Technology Transfer Award

• 2013 NREL Outstanding Business Collaboration Award

• 2015 NREL Outstanding New Technology Licensing Award

• 2015 and 2018 R&D 100 Award Finalist
SwitchGlaze
Making smart windows smarter
NREL focuses on emerging fenestration concepts
Science and engineering fills gaps where standards may not exist
Partnerships with industry to support standard development and transfer
Samples provided by multiple companies

Failure mode analysis based on:
- Temperature
- Illumination
- Cycling Conditions

Maximum stress conditions determined to be at high temp while cycling under illumination

This formed the basis for the ASTM E-2141/E-2953 method
NREL has partnered with the University of Sydney and LBNL to test VIG prototypes under differential thermal stress.

Experimental work supporting development of ISO/DIS 19916.
NREL partnered with the Insulating Glass Manufacturer’s Alliance to research accelerating the ASTM E2190 method

Goal of reducing time to test and accelerate products to market
NREL works with partners on assessing durability of various advanced fenestration concepts

Cost shared basis: DOE supports facility, company pays for testing time

Partners ranging from early stage technologies at university level up to large companies

Test chambers at or near full capacity for 2+ years

Current Program

Electrochromic

Aerogel

VIG

Thermochromic

Photovoltaic
Facilities
Advanced Fenestration Durability Analysis

NREL has developed and maintains multiple systems to perform controlled weatherization and exposure testing.

*Differential Thermal Cycling Unit*
- Highly insulating windows, including framing

*Solar and Thermal Weatherization*
- Controlled Solar and Thermal Exposure
  - Materials and assembly durability
  - Dynamic window technologies

See Also: [http://www.nrel.gov/pv/performance_reliability/indoor_testing.html](http://www.nrel.gov/pv/performance_reliability/indoor_testing.html)
Dynamic Window Durability Testing

**Atlas XR260 Weatherometer**
- ASTM 2141-14 Standard for Absorptive Electrochromic Durability
- Supporting development of other dynamic IG technologies

**Environmental Conditions:**
- Irradiance = 1 Sun ASTM AM 1.5
- Temperature: -10°C to 60°C
- Chamber sample area 78” x 52”
Differential Thermal Stress Testing

Independent control of temperature and RH on both sides of a fenestration sample, or wall section at the same time

Upgrades possible to incorporate pressure as well as UV exposure

- Sample Temperature Range: -50°C to 110°C
- Relative Humidity: 5–95%
- Thermal Ramp Rate: Maximum of 2° C/min
- Sample Size Maximum: 45” x 45” x 8”

Differential Thermal Cycling Unit (DTCU)
Thank you

www.nrel.gov

robert.tenent@nrel.gov

linkedin.com/in/rctenent

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Building Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.