BUILDING TECHNOLOGY AND URBAN SYSTEMS/WINDOWS AND ENVELOPE RESEARCH

Electrochromic Windows

BERKELEY LAB

National Labs Make Dynamically Tinting Windows a Reality

Out of the Lab, Into to the Marketplace

Department of Energy (DOE) laboratories are instrumental in the development of new energy-efficient technologies. In fact, if DOE's 17 national labs were not able to marshal their considerable resources on behalf of industry and absorb the risk inherent in early-phase scientific research, many technologies would simply not exist. Electrochromic (EC) windows are one such technology. Decades of research and innovation by Lawrence Berkeley National Laboratory (LBNL) and National Renewable Energy Laboratory (NREL) have made dynamically tinting "smart windows" a global reality. Lab advances in material science have been the catalyst for new EC window technologies, and lab support—from developing innovative window applications to conducting field studies—has enabled those technologies to evolve and deploy commercially. This multi-dimensional approach to scientific inquiry ensures that research finds its way out of the lab and into the marketplace.

MATERIAL SCIENCE

ADVANCES IN MATERIAL SCIENCE CATALYZE INDUSTRY

DOE labs have a long history of leadership in material science research. With an extensive physical and organizational infrastructure, they provide unique multidisciplinary scientific capabilities that are beyond the scope of most academic and commercial institutions. Since the 1980s, national labs have fostered five dynamic glass companies, SAGE Electrochromics and View Dynamic Glass among them.

ENERGY PERFORMANCE

MEASURING PERFORMANCE DEMONSTRATES VALUE

Objective energy performance data encourages the adoption of new building-envelope technologies. DOE labs have conducted extensive laboratory testing and field studies to measure the performance of EC windows. Simulation tools developed by the labs accurately predict performance and help guide designers, specifiers and building owners in selecting EC windows.

WINDOW APPLICATIONS

INNOVATION FOR THE BUILT ENVIRONMENT

Lab researchers have been instrumental in developing practical applications for EC technology. From creating thin films and testing control strategies to developing scalable manufacturing processes and Active Standard Test Method (ASTM) durability standards—the story of national lab participation in the development of EC windows is the story of innovation.

HUMAN FACTORS

ASSESSING HUMAN FACTORS IN BUILDINGS

Property owners are hesitant to embrace new technologies without knowing how occupants will respond to them. Large-scale DOE lab field studies have demonstrated widespread user acceptance of dynamic windows, encouraging their adoption in everything from office buildings to airports.

Key Lab Contributions to Electrochromic Technology

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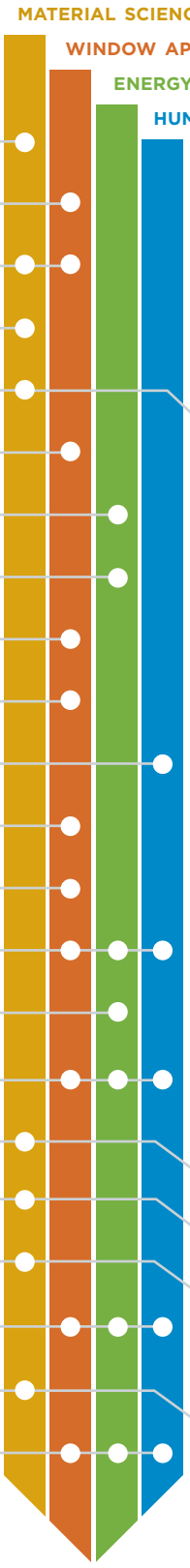
A multi-dimensional approach to research enables EC technology to evolve and deploy commercially

100+ PAPERS PUBLISHED BETWEEN 1973-2018



1973 1st paper on tungsten oxide EC (future NREL researcher)

1980 Thin film EC for windows (LBNL)

1984 Characteristics of tungsten oxide film for EC windows (NREL)

1985 Nickel oxide film properties (LBNL)

1986 Vapor deposition of tungsten oxide EC (NREL)

1989 Application of EC to large windows (LBNL)

1990 Evaluation criteria & test methods (NREL/LBNL)

1992 Modeling of economic benefits (LBNL)

1992 Scalable manufacturing process for tungsten oxide (LBNL)

1994 Impact of EC switching strategies (LBNL)

1996 Visual impact of EC (LBNL)

1998 ASTM standard for durability (NREL)

1999 Method for accelerated durability testing (NREL)

1999 1st US field study (LBNL)

1999 Thermal performance of EC skylights (LBNL)

2003 Full-scale laboratory testing of EC prototypes (LBNL)

2004 R&D 100 award for metal hydride reflective EC (LBNL)

2009 R&D 100 award for reflective EC technology (NREL)

2011 Near-infrared EC coating (LBNL)

2012 1st field study in occupied commercial space (LBNL/NREL)

2015 Patent for ternary nickel oxide EC coating (NREL)

2018 Large-scale field demonstrations (LBNL)

Lab advances in material science launch industry

SAGE Electrochromics, funded by DOE, begins development in 1990 of an all-solid-state, inorganic EC window based on NREL guidance. First EC windows with tungsten oxide thin film ship in 2006.

View Glass licenses metal hydride EC in 2007; switches to tungsten oxide EC for production

e-Chromic Tech. licenses reflective EC in 2009

Heliotrope, an LBNL spin-off, forms in 2012 to commercialize near-IR EC

SAGE Electrochromics licenses ternary nickel oxide EC in 2016