Single-Pane Highly Insulating Efficient Lucid Designs (SHIELD)

SHIELD project teams will develop innovative materials and structures that can more than halve the amount of heat lost through single-pane windows during the winter heating season. These materials and designs would improve a window's thermal insulation, reduce cold weather condensation, and have a minimal impact on the window's appearance. The technologies could also produce corollary benefits in window performance, such as improved soundproofing, that will make retrofits more desirable to occupants and owners of residential and commercial buildings. Each project team will focus on one of three technical categories. The first category seeks transparent, adhesive products that can be applied onto existing windowpanes. These materials must be less than 1/8 inch thick, cost less than $5 per square foot at a manufacturing scale of one million square feet annually, and last for 10 years. The second category includes manufactured windowpanes that can be installed without replacing the window sash that holds the windowpane in place. These windowpanes must be less than 1/4 inch thick, cost less than $10 per square foot at manufacturing scale, and last for 20 years. Finally, the SHIELD program includes innovative technologies that can enable products in the first two technical categories. The SHIELD program includes a Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) award category.

PROJECT DESCRIPTIONS

Argonne National Laboratory – Lemont, IL

Self-Assembled Nanocellular Composites with Super Thermal Insulation and Soundproof for Single-Pane Windows - $3,102,671

Argonne National Laboratory and its partners are developing a thin, transparent foam that can be manufactured with a low-cost, continuous fabrication process to improve thermal insulation and soundproofing in single-pane windows. The team will use advanced molecular design and materials synthesis of both nanoparticles and a polymer to create a nanostructure that self-assembles into a well-ordered composite. The resulting nanofoam could demonstrate four times better insulating capacity than conventional foams. To fabricate the nanofoam, the team will devise a low-cost mixing technique that enables good dispersion of the nanoparticles in the polymer. Finally, the team will integrate acoustic metamaterial structures into the nanofoam to improve sound isolation.

Arizona State University – Tempe, AZ

Single-Pane Windows with Insulating Sprayed Particulate Coatings - $2,197,800

Arizona State University (ASU) and its partners are developing a windowpane that incorporates multiple layers to improve thermal insulation, prevent condensation, and enhance the strength of the windowpane. The team's thermal barrier will be composed of a transparent silica layer and a low emissivity layer, both of which will be applied to a pane of glass in the factory using a novel supersonic aerosol spraying process. The windowpane will also include a separate polymer layer that helps prevent water condensation and improves mechanical strength. ASU estimates that by using its aerosol spraying method, instead of conventional wet chemical approaches, the system will cost only $1 per square meter more than existing panes and save consumers approximately $100 per year in energy costs.

Aspen Aerogels, Inc. – Northborough, MA

Aerogel Insulated Pane as a Replacement for Panes in Single-Pane Windows - $2,751,377

Aspen Aerogels, Inc. and its partners are fabricating a windowpane that incorporates a silica aerogel to provide thermal insulation and condensation resistance. This UV-stable silica aerogel will be placed between two thin sheets to create a double-glazed pane. The team will manufacture the pane using a supercritical drying method that is less costly and enables new molding strategies. If successful, Aspen Aerogels' windowpane could be used to replace single panes in windows where thickness and weight preclude replacement with double-pane units.

Eclipse Energy Systems, Inc. – Saint Petersburg, FL

Eclipse Shield - $1,249,791

Eclipse Energy Systems, Inc. is developing its proprietary "EclipseTEC" material into a window film, which can be applied to single-pane windows to improve thermal insulation. EclipseTEC demonstrates high visible transmissivity and low emissivity, making it a strong candidate for transparent window film that can be used to prevent heat loss. Eclipse will develop a roll-to-roll manufacturing process to demonstrate cost-effective scalability of the technology.

Oak Ridge National Laboratory – Oak Ridge, TN

Low Cost, Multilayer, Highly Transparent and Thermally Insulating Hybrid Silica-Polymer Film - $2,540,000

Oak Ridge National Laboratory and its partners are creating a highly transparent, multilayer window film that can be applied onto single-pane windows to improve thermal insulation, soundproofing, and condensation resistance. Low-cost nanoporous silica layers that exhibit superior optical and mechanical properties will be used to improve thermal insulation. A separate layer of polyvinyl butyral, which is commonly applied to windows for soundproofing, will be added between silica sheets to enhance sound absorption. The team's window film will also include a layer of low-emissivity film to minimize heat transfer.

PARC, a Xerox Company – Palo Alto, CA

Scalable Transparent Thermal Barriers for Single-Pane Window Retrofits - $2,887,312

PARC and its partners are developing a new windowpane that incorporates a transparent polymer aerogel to prevent thermal losses. The team's polymer aerogel exhibits lower thermal conductivity and greater mechanical flexibility than silica aerogels. The team is also developing a pilot-scale roll-to-roll manufacturing process to demonstrate that fabrication of the aerogel and its application onto windowpanes can be scaled. The team's new windowpane will be of similar weight and thickness of existing single panes and therefore could replace existing windowpanes in single-pane units.

Regents of the University of California, Los Angeles – Los Angeles, CA

THermally INsulating traNsparEnt barrieR (THINNER) Coatings for Single-Pane Windows - $1,200,000

The University of California, Los Angeles (UCLA) is developing a transparent, multilayer coating that can be deposited at the windowpane factory to improve thermal insulation. UCLA will develop a nanoporous titania/silica coating that will reduce heat conduction and improve condensation resistance. The team will also advance a high-temperature spray-on process for the coating that is compatible with conventional flat glass manufacturing.

SRI International – Menlo Park, CA

Window Retrofit Applique using Phonon engineering (WRAP) - $2,968,501

SRI International and its partners are developing a "phononic metamaterial" that could be an unparalleled thermal insulator for single-pane windows. The team's material will be used as a non-porous, transparent layer that can be applied onto single-pane windows. SRI's product will greatly improve window thermal insulation and other properties, including soundproofing.

University of California, San Diego – La Jolla, CA

"Thinner Than Air": Polymer-Based Coatings of Single-Pane Windows - $1,400,000

The University of California, San Diego (UCSD) is developing a thermal- and acoustic-insulating film that can be applied onto windowpanes to reduce heat loss and condensation. The material contains transparent, thin sheets and stabilized thermal barrier layers. The outermost layer will have a low-emissivity coating that helps improve thermal insulation while also resisting condensation and abrasion. The team's materials use low-cost polymers that help reduce the overall cost of the film.

University of Colorado Boulder – Boulder, CO

Advancing Insulation Retrofits from Flexible Inexpensive Lucid Materials (AIR FILMs) for Single-Pane Windows - $1,800,000

The University of Colorado Boulder (CU-Boulder) is developing a flexible, transparent window film that can be applied onto single-pane windows. The team's thermal barrier is based on liquid crystalline phases of nano-cellulose aerogel that have low-emissivity properties, which will help prevent heat loss through windows. CU-Boulder will produce the thermal barrier using low-cost cellulose nanorods synthesized from food industry waste. The team aims to produce a film that the consumer can easily apply, which could decrease costs by eliminating professional installation labor expenses.

These projects have been selected for negotiation of awards; final award amounts may vary. Last updated: 5/17/2016

Virginia Commonwealth University – Richmond, VA

Fabrication of Inexpensive, Transparent Aerogel Panes - $859,891

Virginia Commonwealth University (VCU) and its partners are developing technologies that address shortcomings with manufacturing and using aerogel for window retrofits. VCU is modifying the chemistry and processing of nanoporous silica aerogels to reduce the cost of their production and increase their transparency for use in window retrofits. The team will also crosslink aerogels to produce stronger aerogels that are more durable. VCU's innovations could result in better-performing, more affordable silica aerogels for window retrofits.

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Selections

IR Dynamics, LLC – Santa Fe, NM

Dynamic IR Window Film to Improve Window Energy Efficiency - $1,950,000

IR Dynamics, LLC and its partners are developing a transparent nanomaterial that, when integrated into flexible window films, will improve thermal insulation and manage solar heat gain. The window films include polymer-embedded nanophase materials, such as low-cost nanosheets, that act as a thermal barrier, and thermochromic materials whose infrared reflection properties switch on and off automatically at specified temperatures.

NanoSD, Inc. – San Diego, CA

Retrofittable and Transparent Super-Insulator for Single-Pane Windows - $3,000,000

NanoSD, Inc. is developing a transparent, nanostructured film that can be applied onto existing single-pane windows to reduce heat loss. The team's material features unique nanoshell structures that are tightly packed to create a strong thermal barrier. The team will apply a low-emissivity coating to further enhance the material's ability to insulate and incorporate materials to reduce abrasion and condensation. To enable cost-effective fabrication of the product, NanoSD will focus on incorporating all of these steps into a roll-to-roll manufacturing technique.

Triton Systems, Inc. – Chelmsford, MA

Energy Efficient Window Thermal Control - $3,224,500

Triton Systems, Inc. and its partners are developing a multilayered coating for manufactured windowpanes that could improve the efficiency of single-pane window units. The technology consists of a low emissivity nanocomposite film that transmits light better and costs less than commercially available window films. The coating also includes a mesoporous innerlayer to provide thermal insulation. The team will enhance the pane's durability by incorporating a nanocomposite edge seal on anti-reflection soda lime float glass.