Metal-Elastomer Composite Edge Seal for Vacuum Insulated Glass Windows

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OTHER INFORMATION

KEYWORDS

windows, building windows, glass, seals, edge seals, efficiency, energy, energy efficient, architecture, construction

CATEGORIZED AS

- **Materials & Chemicals**
- Other

RELATED CASES

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BACKGROUND

Energy loss through building windows accounts for 60% of total building energy consumption, and in commercial buildings, space heating remains a dominant source of energy demand. Improving building thermal efficiency, particularly by reducing energy loss, has become a central goal in sustainable architectural design, and Vacuum Insulated Glazing (VIG) has emerged as a promising solution. VIG consists of two glass panes separated by a narrow-evacuated gap that significantly suppresses heat transfer by conduction and convection. In addition to its superior thermal insulation, VIG enables thinner window profiles compared to conventional multi-pane glazing systems, making it attractive for both energy and design applications.

However, widespread adoption of VIG remains limited due to persistent challenges related to the high manufacturing cost due to time-consuming fabrication steps. A primary limitation is the edge seal, which is responsible for maintaining the vacuum over time. Common sealing materials include solder glass, lead based alloy, and indium-based alloys. These materials are either highly thermally conductive, which can lead to windows that deform when subjected to large temperature differentials, or they require high melting temperatures during processing, which is time-consuming and compromises the strength of tempered glass. Significantly reducing the manufacturing time is critical in reducing VIG cost to be comparable as conventional dual-pane insulated glass units (IGUs), making VIGs of significant commercial interest.

DESCRIPTION

Researchers at the University of California, Santa Barbara have created a novel metal-elastomer composite edge seal that can significantly reduce manufacturing time, in addition to maintaining excellent thermal insulation and mechanical flexibility for vacuum insulated glass windows. This new edge seal design for vacuum insulated glazing (VIG) windows uses a metal-elastomer core-shell composite to maintain a durable vacuum space between glass panes. Unlike conventional edge seals that require high-temperature annealing and suffer from rigidity and permeability issues, this composite combines a low melting point solder metal shell (~120°C) with a flexible elastomer core, low gas permeability, and improved mechanical flexibility. In addition, the core-shell structure can accommodate thermal strain caused by large temperature differentials without compromising the strength of tempered glass. The seal can be rapidly applied via localized Joule heating of the metal shell, eliminating lengthy high-temperature manufacturing steps, enhancing product durability, and significantly reducing costs.

ADVANTAGES

- Low gas permeability ensuring long-term vacuum maintenance
- Improved mechanical flexibility to accommodate thermal stresses
- Reduced manufacturing time through localized low-temperature sealing process
- Maintains tempered glass strength by avoiding high-temperature annealing
- Cost-effective production using inexpensive materials and extrusion methods
- Minimized thermal bridging via optimized seal geometry
- Enhanced durability against delamination and vacuum failure

APPLICATIONS

- New construction and retrofit vacuum insulated window units

- Energy-efficient architectural glazing for commercial and residential buildings
- Thermally and acoustically insulated enhanced window products
- High-performance window manufacturing seeking faster production techniques
- Sustainable building materials focused on reducing heating and cooling costs

PATENT STATUS

Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Salt-Rejecting Continuous Passive Solar Thermal Desalination Via Thin-Film Condensation
- Devices and Methods for 3D Printing of Highly Ordered Composite Materials
- Cryogenic Magnetocaloric Materials and Systems for Efficient Hydrogen Liquefaction Cooling
- Interstitial-Engineered Refractory Alloys

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