SCALABLE AND COST-EFFECTIVE ROLL-TO-ROLL ADDITIVE MANUFACTURING OF HIGHLY DURABLE SILICA AEROGEL BUILDING INSULATION

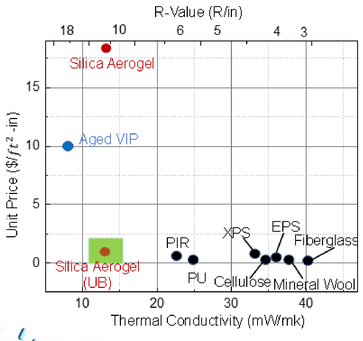
AN EXCEPTIONAL LOW-COST AND ECO-FRIENDLY SUPERINSULATION ALTERNATIVE FOR BUILDING ENERGY EFFICIENCY

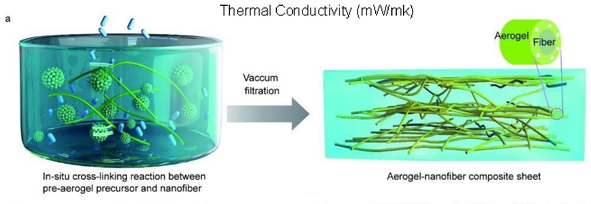
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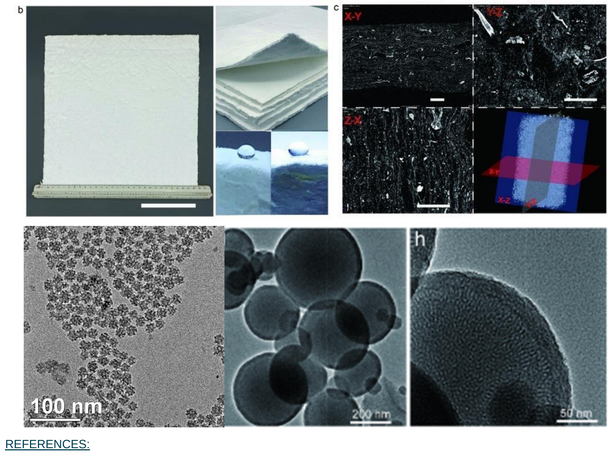
INTRODUCTION

Silica Aerogel Building Insulation: The major drawback for large-scale adoption of silica aerogels as a standard insulation material in buildings is their high production cost of supercritical drying and mechanical instability.

- Opportunities: The development of a cost-effective retrofit insulation that provides high R8/inch; primary energy saving of 0.265 Quads, CO_2 emission saving of 14 Mt.
- Low-cost and scalable manufacturing: high-throughput production (high-yield and continuous processes) at near standard temperature and pressure and avoid exotic or toxic chemistries $0.85/ft2-inch.
- Low-cost and robust installation: fast and easy installation, minimize occupant disturbance during the retrofit effort, and withstand common handling and installation practices.
- Durability: fire-retardant, structure, moisture, soundproof requirements.







Approach

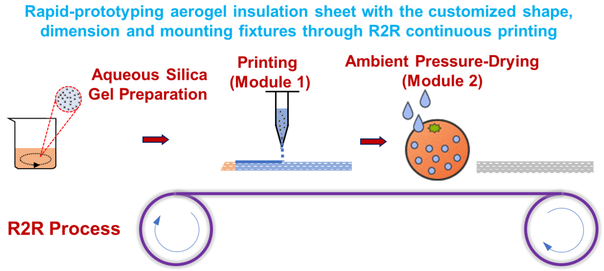
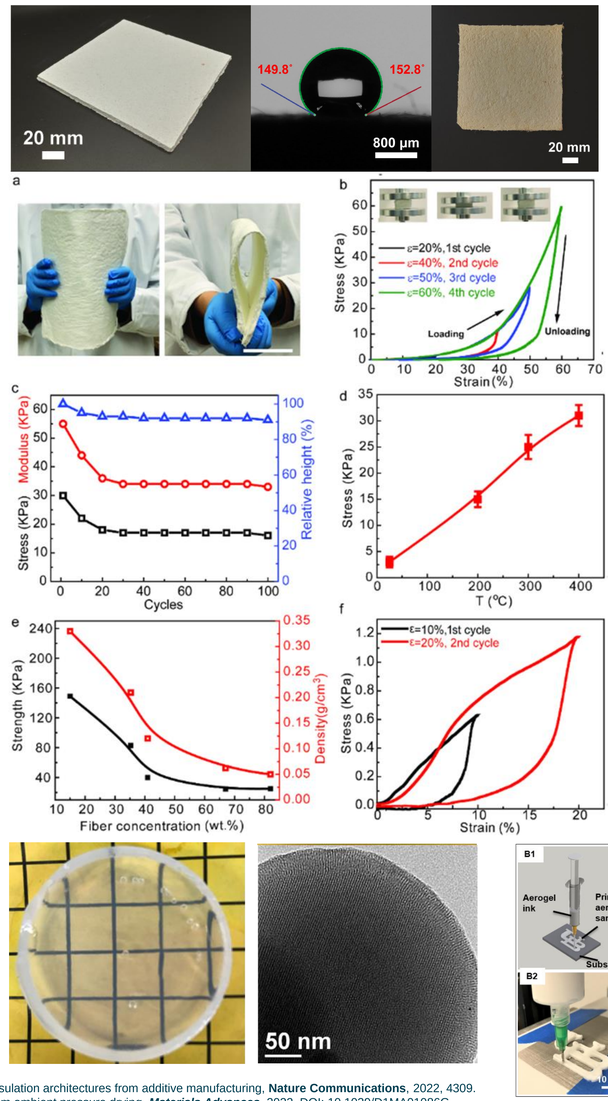
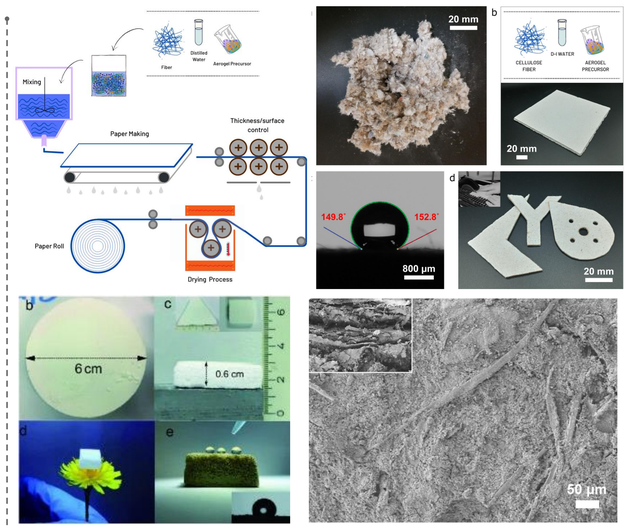
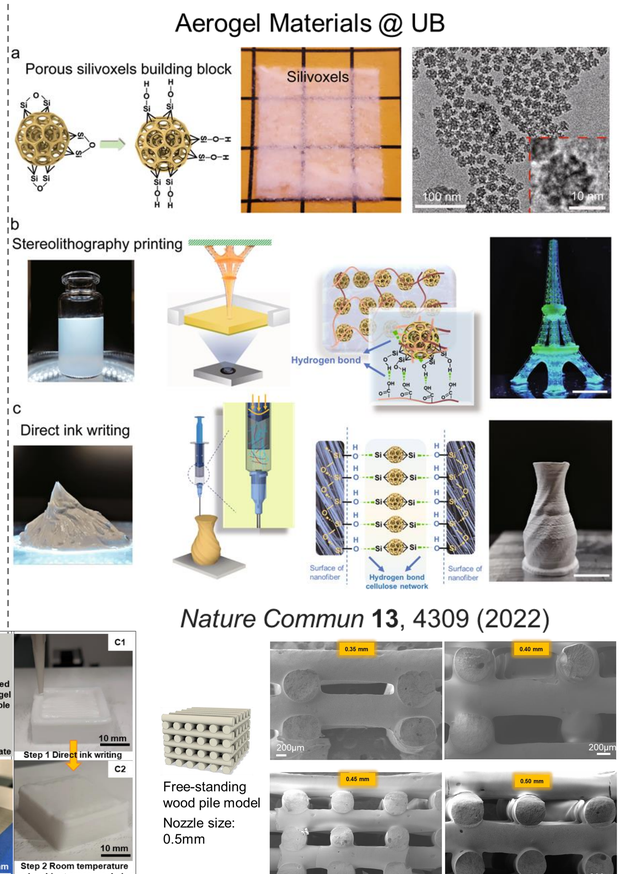


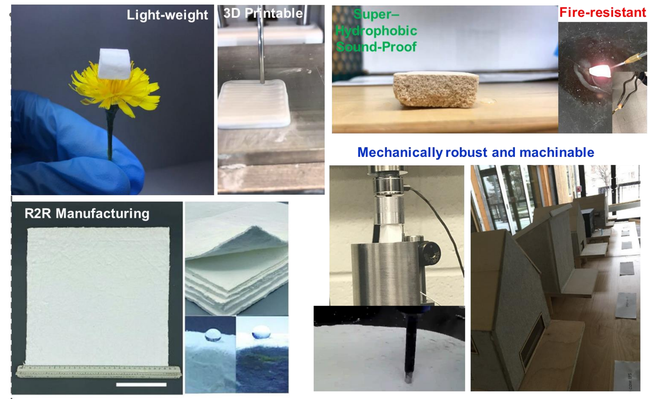
Figure 1. Flowchart of the silica aerogel insulation panel.







PROJECT IMPACT



Materials Characteristics	
Materials	SiO_2
Density (g/cm³)	0.05
Thermal conductivity (W/m.K)	**0.018**
R-value (ft²·°F·h/BTU)	**8**
Modulus	Papersheet: 37 KPa ~ 21 MPa Monolith: 100 MPa
Maximum recoverable strain (%)	Papersheet: 50
Soundproof reduction (dB.%) under 2,000Hz	16.7



A scalable cost-effective silica aerogel manufacturing

- Low-cost Aerogel Insulation Material: A low-cost silica aerogel insulation could reduce the unit price by 90% (project target: ~$240/kg, or $0.85/ft2-inch), meeting DOE's cost target. According to the report by Allied market research in 2014, the interest in silica aerogel insulation is illustrated by the rapid growth of the aerogel market: in 2004, about $25M of aerogel insulation materials were sold, but this had increased to $500M by 2013 (expecting $1,927M by 2021).
- R2R Manufacturing: R2R manufacturing with ambient-pressure drying is the main contributor to the reduced production and installation cost of silica aerogel. R2R manufacturing can reduce energy costs by 50% and material costs by 90%. Because R2R manufacturing eliminates tooling, a product may be manufactured on the same day that the design is completed; lead time constraints are eliminated. An aerogel insulation material through near-net-shape manufacturing, meets health safety and durability (fire, structure, moisture and acoustic code) requirements.

Aerogel insulation materials chemistry, mechanical/thermal/soundproof — University at Buffalo, The State University of New York

Thermal insulation R2R manufacturing — UNIFRAX

ENERGY.GOV Office of ENERGY EFFICIENCY & RENEWABLE ENERGY Building Technologies Office

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