Thermal Energy Storage (TES) Applications
Integrated Strategy Enables Impactful Innovation
Materials to Components & Systems for Thermal Energy Storage in Buildings
Model: 3-D transient model to predict the performance of the material.

Experiments: New experimental facility to characterize the performance of bulk TES materials.

Validation: Validated model predicts the response accurately.

Thermal Cycling: Specific energy throughput calculated over cycles.
HVAC-Integrated Composite Phase-Change Material (PCM)

Materials characterization
Develop and characterize high-conductivity composite phase-change materials

Heat exchanger and HVAC system design
Model and design thermal storage heat exchangers and systems

Prototype characterization
Build and characterize HVAC-integrated thermal storage

Energy and demand analysis
Evaluate new thermal storage using HVAC system and building modeling

Expanded graphite

nm to μm scale

~100 cm
Thermal Resistances and Model Comparison

Simulation results agree with the measured module temperatures.
Tunable TES & Thermal Switch for Smart Building Envelopes

Multi-physics multi-scale modeling
Demonstrate maximum potential of using tunable thermal energy storage and thermal switch to support grid flexibility

**Controlled thermal switch**
To vary thermal resistance

**Dynamic tunability in solid-state PCM**
Comb-branch Micro block Polymer
Salt Hydrate/Graphite PCM Matrices

**Porous Expanded Graphite**
Host matrix for PCM with high specific area and nano/micro porosity

**Hydrophilic Surface Modification**
Surface modification to enable loading of hydrophilic PCM into hydrophobic graphite

**Improved Wetting**
Improved wetting and low contact angle of PCM on porous graphite surfaces

**Lattice Matched Nucleating Agents**
Incorporation of lattice matched nucleating agents for supercooling reduction

**PCM phase change composite**
High thermal conductivity, high energy density PCM composite
Thermal Diodes: Directional Heat Transfer and Thermal Management System

Forward Heat Flux
Reverse Heat Flux

Taken from HEATER Big Idea Presentation.
Ravi Prashant LBNL
Switchable/Tunable Thermal Conductivity of Colloidal Nanocrystals

Time Domain Thermal Reflectance
Thermal conductivity measurement for colloidal nanocrystal thin films

3-Omega Method
Thermal conductivity measurement for bulk, thin film and powder

Switchable Thermal Conductivity
Study the influence of different type of ligands and Cores on thermal conductivity

Tunable solid-solid Phase Change
Study the influence of core+ligand+bonding on phase change behavior
Thank You

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