Towards High Energy Density, High Conductivity Thermal Energy Storage Composites

Thermal energy storage (TES) materials absorb transient pulses of heat, allowing for 1) rapid storage of low-quality thermal energy (hot or cold), and 2) effective temperature regulation as part of a thermal management system. The performance of a TES material is given by how much heat it is able to absorb, and how quickly it is able to absorb it – the latter property is governed by the material’s volumetric energy storage density and its thermal conductivity. For aerospace applications, weight and volume of TES materials and components are especially critical.

This presentation describes recent development of hydrous salt-based TES materials and composites at the Air Force Research Laboratory. Hydrous salts offer nearly double the volumetric energy densities (~0.4 MJ/m^3) and double the thermal conductivities (~0.5-0.6 W/m/K) of state of the art paraffin TES materials. Despite these advantages, hydrous salts are known to be susceptible to undercooling, chemical segregation (changing the solidification and melting behavior over large numbers of cycles), and material incompatibilities. Furthermore, the thermal conductivity of pure hydrous salts remains too low for high cooling power applications. Here, we discuss recent progress towards solutions to these challenges in the composite system LiNO3-3H2O/graphitic foam. This system takes advantage of both the high thermal energy storage density of the hydrous salt LiNO3-3H2O and the high thermal conductivity of graphitic foams.

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