Material Property Study of Thermal Battery Components

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ABSTRACT

The aim of this work is to enhance the knowledge base of material properties that characterize thermal battery performance under non-operating and operating conditions; the latter presenting elevated temperature, vibration, shock, and acceleration levels typical of both tactical and strategic applications. Though sophisticated electrical and thermal models to guide some portions of the design of thermal batteries have been developed, some portions needed to integrate mechanical performance with chemical and electrical behavior have been lacking.

In order to enhance and refine modeling and design tools, multiple physical properties of the thermal battery components must be known. Key component physical properties being determined include: the storage modulus, thermal expansion, and coefficient of friction. The components of the thermal battery being examined address many of those needed for a comprehensive study, including electrodes, separators, insulation, and canister materials.

The storage modulus was determined with the use of a dynamic mechanical analyzer (DMA). The single cantilever beam testing process was used for the TA instrument 2980. The method used involved ramping from room temperature to 50 ^{o}C, then equilibrating at 50 ^{o}C, after which the temperature was ramped by 5 ^{o}C per minute to 550 ^{o}C. A frequency of 1 hertz and amplitude of 10 μm were used.

The thermal expansion was determined with the use of the Anter Corporation's WorkHorse II dilatometer. The method used involved ramping from room temperature to

50 ^{o}C, then equilibrating at 50 ^{o}C, after which the temperature was ramped by 5 ^{o}C per minute to 550 ^{o}C in 25 degree segments. A dwell time of 5 minutes was used between each 25 degree segment. For the electrode samples, thermal expansion test were done under inert conditions by the use of Argon gas.

For the measurement of the coefficient of friction an inclined plane system was used. The coefficient of friction was measured under different conditions. These conditions include with or without added weight, and at room temperature or at an elevated temperature.

Thermal battery packaging and performance requirements are being pushed to the limits. The accumulation of material property data on the components of the thermal batteries will aid in the development of thermal models used to design thermal batteries. This paper identifies the gaps in available data for thermal battery modeling and presents new results for battery component materials from ambient to elevated temperatures.