Supplementary Material

**A novel design for battery cooling based on highly thermally conductive phase change composites encapsulated by 3D printed polyethylene/boron nitride layer**

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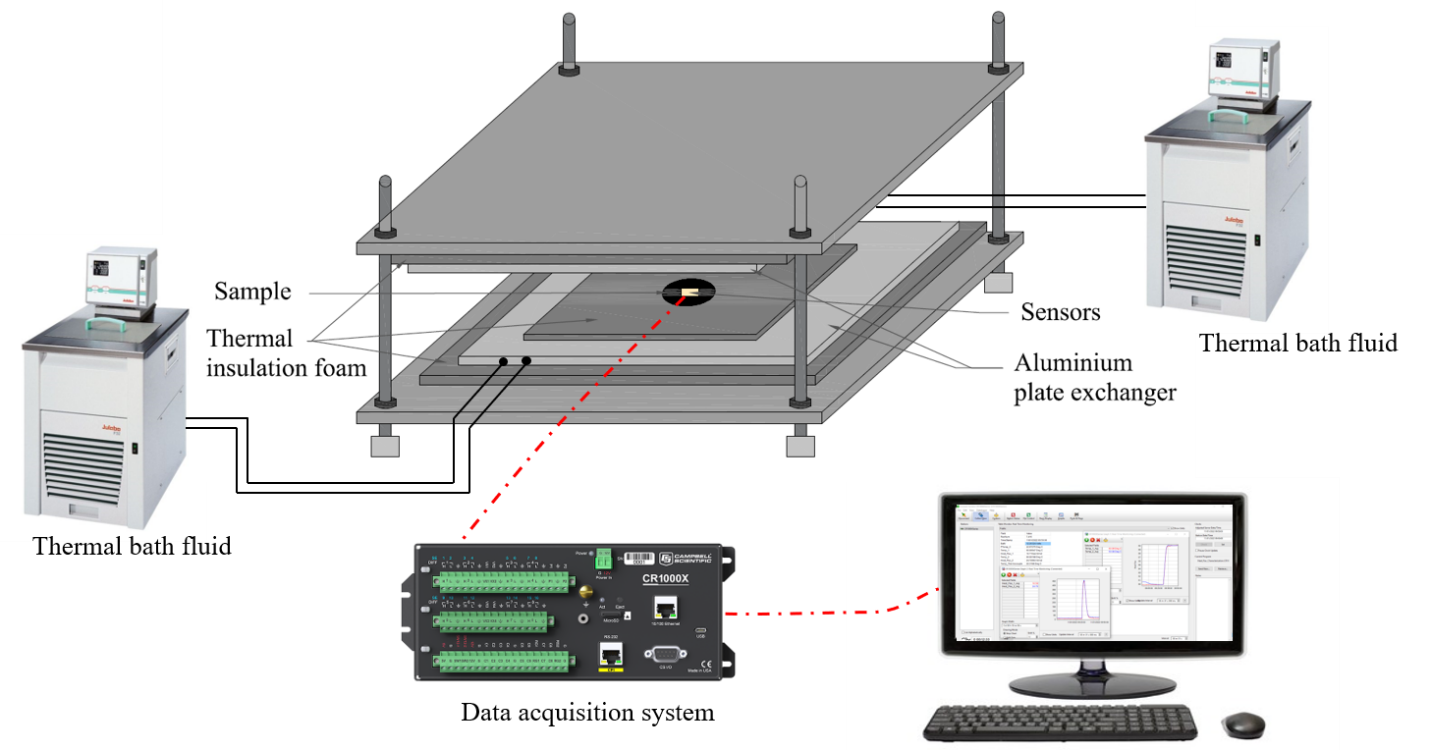
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**Note 1:** Transient guarded hot plate (TGHP) test set up and results

A homemade TGHP apparatus was used to measure and compare the thermal conductivity of the composite samples measured from the Hot disk. The experimental setup is shown in Fig. S1. The top and bottom aluminum heat exchangers are connected to two thermoregulated fluid baths to maintain temperatures of the heat exchangers at set points with a precision of 0.1 ℃. The heat flux sensors and T-type thermocouples on the top and bottom sides of the composite samples of size 3.5 × 4.0 × 0.8 cm measure the heat flow to and from the sample and the corresponding temperatures. The data logger (CR1000X, CampBell Scientific, USA) connected to the sensors records the heat flux and temperature at regular time steps of 5 s.



**Fig. S1:** The homemade transient guarded hot plate apparatus for the thermal conductivity measurement [1,2]

The lateral sides of the samples and heat exchangers were insulated with polyurethane foam to eliminate the unnecessary heat transfer between the surroundings.

According to ASTM E1530, the thermal resistance (Rs) of the sample placed between two different temperatures, T1 and T2 is given by Eq.

[S1]

Q is the average heat flow to and from the sample at steady state, and N and Ro are the temperature and load-dependant parameters obtained by calibration at each particular set of conditions.

N and Ro are obtained graphically as the slope and intercept in the Rs Vs (T1-T2/Q) plot for the reference material at different thicknesses (as shown in Fig. S2). The values of N and Ro were 6260.82 and -9.91, respectively.



**Fig. S2:** Thermal resistance Vs (T1-T2/Q) plot for the reference material

Similarly, the thermal resistance of the composite sample subjected to a temperature gradient was calculated using Eq. 1. The thermal conductivity is obtained as in Eq. S2

[S2]

where Δt is the thickness of the composite sample.

The thermal conductivity of the encapsulated GF\_RT44 and GF\_RT35 composite samples are shown in the Table. The experiments were repeated three times at different temperature gradients, and the standard deviations in the thermal conductivity measurements are given in parentheses.

**Table 1:** Thermal conductivity of the composite samples obtained from the TGHP apparatus (standard deviations of 3 repeated measurements are given in parenthesis)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Composite** | **(T1-T2)/Q** | **Rs (cm2.℃/W)** | **Δt (mm)** | **λ (W/m.℃)** |
| **GF\_RT44** | 0.00756 | 37.4204 | 16.5 | **4.41 (0.05)** |
| **GF\_RT35** | 0.00754 | 37.2952 | 16.2 | **4.34 (0.01)** |

**References**

[1] I. Chriaa, A. Trigui, M. Karkri, I. Jedidi, M. Abdelmouleh, C. Boudaya, *Appl Therm Eng* 2020, *171*, 115072.

[2] S. Nishad, H. Mohammed, P. Sobolciak, I. Krupa, *Journal of Materials Research and Technology* 2023, *24*, 3717.