TECHNICAL DATA SHEET

Thermal Runaway Shield (TRS)

April 2022

ABOUT KULR TECHNOLOGY

KULR'S disruptive thermal management technologies strive to fulfill an addressable $24 billion thermal management systems market. KULR's integrated design approach offers comprehensive solutions in thermal interface materials, lightweight heat exchangers, and protection against lithium-ion battery thermal propagation. Our high-performance solutions can be designed to fit almost any power or electronic configuration, including extremely demanding spaces or for applications where size and weight restrictions are a concern.

PRODUCT DESCRIPTION

KULR Technology's patented Thermal Runaway Shield (TRS) is industry leading in its ability to quench and mitigate thermal runaway events in storage, transportation, and built-in operational pack designs. TRS's excellent performance is based in its ability as a phase change material to absorb large quantities of energy as a liquid and subsequently transition into a vapor.

TRS is installed in all KULR SafeX products as the system's main thermal runaway mitigation material.

TRS is also available for custom applications. The material can be integrated directly into a battery pack producing a system with built in passive propagation resistance and thermal runaway mitigation. Our patented technology allows the liquid in the TRS to be transported passively around the system to where it's needed most to relieve thermal stress. This further helps in preventing thermal runaway from occurring.

FEATURES AND BENIFITS

- Excellent solution for TR probable environments
- Can be designed into a new system, or incorporated into an existing one
- Passively helps with propagation resistance

Property	Value	Test Method
Construction	Encapsulated Coolant	N/A
Maximum Energy Rating	Up to 2.1KWh (Standard Size)	DOT Approved TR Test
Thickness [1]	0.005in	Micrometer
Tensile Strength (at break)	>14 lbs	ASTM D882
Tear Strength (375F;26psi; 1 sec)	>1.7lbs	ASTM689
Seal Strength (375F;26psi; 1 sec)	12 lbs/in	ASTM D882
Puncture Strength	>25 lbs	TMS 101-C, Method A
Rupture Temperature	112°C	N/A

[1] Per layer of encapsulation material

Property	Value	Benefits
Density Bulk Areal	 0.7 g/cc 0.13 g/cm^2	 Low mass
Electrical Conductivity	Surface nonconductive	No leakage currents from the battery
Thermal Conductivity (x-y) Standard version Enhanced version	 0.4 W/m^2/K 25 W/m^2/K	 Enhanced version provides heat-spreading function
Phase Transition Temperature	100°C	Good margin for thermal runaway shielding
Specific Heat	3.0 J/g/°C (up to 100°C)	Increased system thermal inertia
Thermal Energy Dissipation	1700 J/g at 100°C	High thermal dissipation per mass
Hardness	NA, pliable	Amenable to various cell arrangements tolerant of battery pack dimensional variations
CTE	NA, pliable	Minimal mechanical stress coupling
Damage on Freezing	None	Tolerant of cold temperatures

Resistance to Propane Torch in Open Air	Value	Benefits
Standard version	19 sec. for back face to reach 100C No sustained combustion after heat source removed. Cooled to 40C in 1 min.	Good resistance Fire safety
Enhanced version	54 sec. for back face to reach 100C No sustained combustion after heat source removed; cooled to 60C in 1 min.	Excellent resistance Fire safety

Durability and Reliability

Envelope material Mullen burst = 57 psi. Seal strength = 12 lb./in. Assembled TRS's currently being evaluated under normal conditions of use.

cooler · lighter · safer

TYPICAL APPLICATIONS

Used in battery applications where a PPR is needed.

AVAILABILITY

Please contact KULR Technology Group for additional information.

DISCLAIMER

Data on this Technical Data Sheet (TDS) are typical values and for reference only. The information provided in this TDS, including but not limited to the recommendations for use and application of the product, are based on our knowledge and experience of the product. The product can have a variety of different applications, as well as differing working conditions and environments that are beyond our control. Factors or events that could cause actual results to differ may emerge from time to time, and it is not possible for us to predict all of them. We cannot guarantee future results, performance or achievements. Furthermore, no representations or warranties are made as to the accuracy or reasonableness of any assumptions on which the data or information is based.

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