

# Internal Short Circuit (ISC) Trigger Cell



## About KULR

KULR Technology has over 20 years of experience in the high-performance aerospace industry having won over 500 contracts with NASA, Raytheon, Boeing and JPL. KULR's carbon fiber based thermal management solutions have been utilized in the International Space Station, Mars Rover, and Mercury Messenger.

## Product Highlight

KULR has exclusively licensed ISC device technology (from NREL) and applied it to Li-ion cell customization and fabrication. KULR can offer ISC cells for all commercial categories: 18650, 21700 & pouch cells. With KULR ISC cells, an internal short circuit can be intentionally triggered on demand. The failure modes and safety issues after ISC occurrence can be identified and studied with the aid of ISC cells. ISC cells are a valuable engineering tool for research institutes, battery manufacturers, and OEMs looking to improve the performance and safety of Li-Ion batteries.

## Background

- The Li-ion battery is rapidly gaining popularity as a power source in electric vehicles, consumer electronics and power tools due to its high energy density and power; making its safety and reliability of utmost importance.
- One of the most important safety failure mechanisms of the Li-ion battery is naturally-occurring internal short circuit (ISC).
- Spontaneous ISC could result from a manufacturing defect, aging or an internal stress condition. Due to the latent feature of ISC, it is almost impossible to predict its occurrence.
- ISC can cause overheating, fire or even thermal runaway which could trigger catastrophic propagation within a battery pack.

## Key Features

- Controllable internal short circuit failure is initiated by heating the trigger cell
- The trigger temperature is readily achieved (40-60°C)
- Location of ISC device inside cell can be customized
- The cell performance is not impacted by ISC pad implantation
- The cell structural integrity is preserved prior to triggering
- Thermal runaway propagation events can be induced by ISC

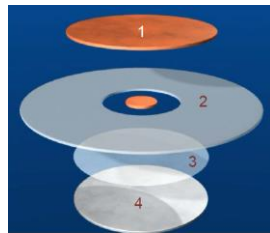
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## Benefits

- Emulating an internal short circuit in a reliable and simple way
  - Heating to 50-60°C triggers ISC
  - Consistent and reliable ISC triggering is verified
- Intact cell structure before ISC initiation
  - Common approaches involve crush or penetration
  - No mechanical damage in ISC triggering with KULR cells
- Preferred way to trigger thermal runaway
  - External heating to around 200C can trigger thermal runaway
  - Nail penetration or crush can trigger thermal runaway
  - KULR ISC cell best emulates natural failure mechanism
  - Timing and location of ISC triggering can be controlled

## Demonstration of ISC Pad and Implantation



Top to Bottom:  
1. Copper Pad  
2. Battery Separator with Copper Puck  
3. Wax - Phase Change Material  
4. Aluminum Pad

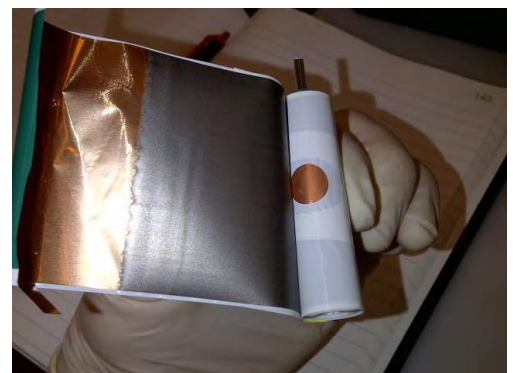
Concept of ISC pad



Configuration of ISC pad implantation



ISC pad prototype



ISC pad implanted in Jellyroll

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