

SBE Inc.

SBIR Phase I Update

**“High Temperature, Low Cost DC Link
Capacitor for HEV Inverters”**

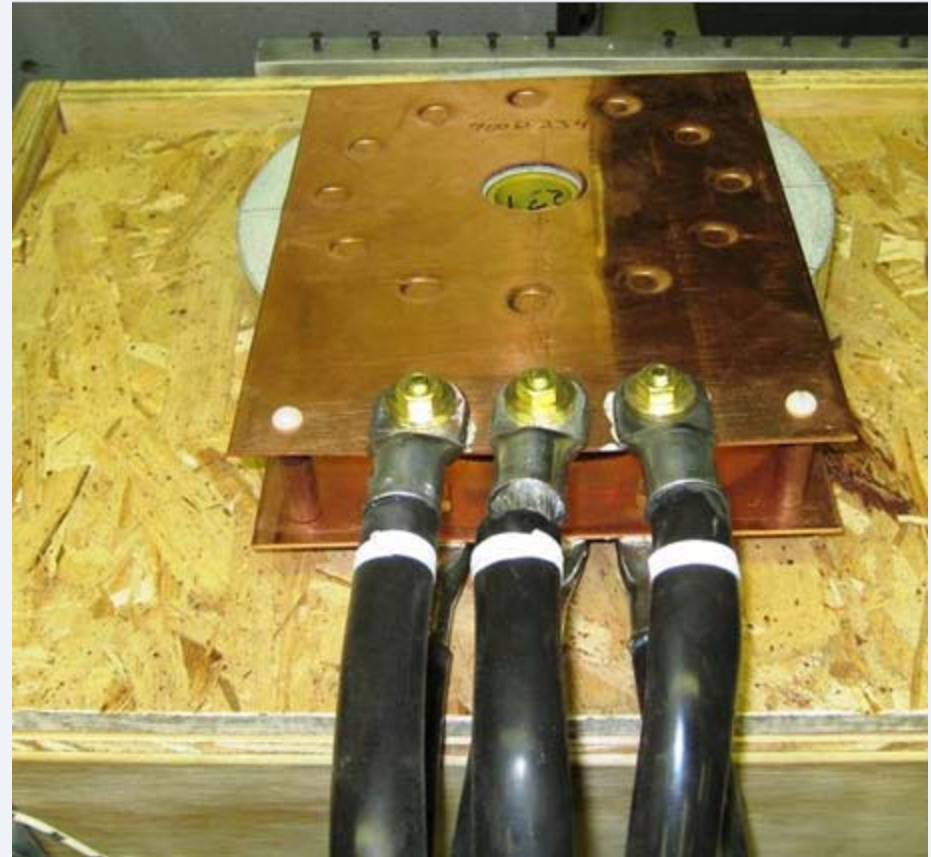
May 2008



DoE SBIR Discoveries

One of many ways to connect strong AC Current to a ring capacitor

SBIR Phase I research determined that the effects of the terminal attach method can determine the failure point (temperature and rms current) for a low internal loss device such as the Ring capacitor.

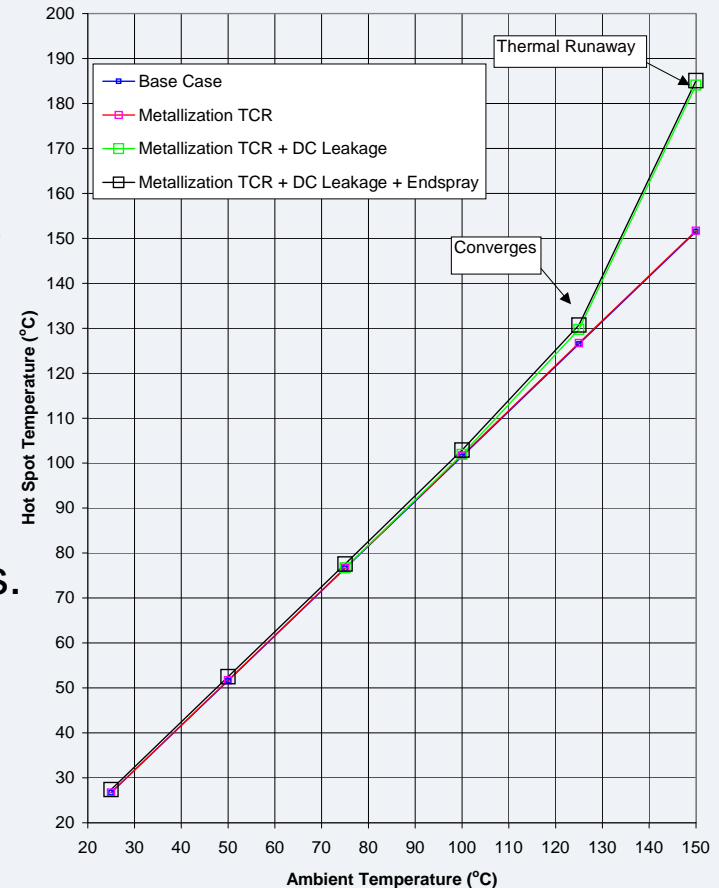


DoE SBIR Discoveries

2D Modeling results showing the capability of the ring shape to operate up to 125°C ambient based on leakage current material properties of polyprop.

Since initial testing of Power Rings has shown 2.5°C hot spot temperature rise at 240Arms (~50°C ambient). Very Close to our previous simulation results.

Our conclusion is that 125°C operation for some voltage/current conditions is feasible.

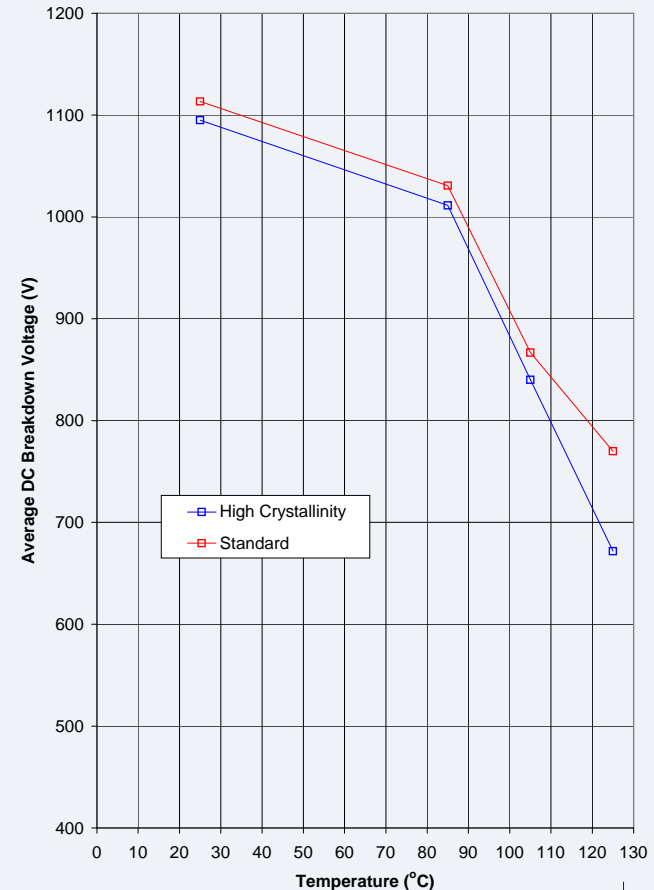


DoE SBIR Discoveries

As operating temperatures are increased, the DC breakdown Voltage of the Polypropylene film will become a limiting factor

Assuming expected useful DC Voltage ranges of 500Vdc continuous and up to 750Vdc transient for the DC Link Capacitor application, the High Crystallinity Film option appears not viable.

Standard Polypropylene film is likely usable up to 125°C based on transient DC breakdown.



DoE SBIR Conclusions

- ⚡ The SBE Power Ring design has very low internal temperature rise due to low losses.
 - ⚡ Likely hot spot limitation of $\sim 125^{\circ}\text{C}$
- ⚡ Polypropylene material characteristics are likely to limit the capacitor in the DC Link application even when a Power Ring is used
 - ⚡ Likely limitations of $\sim 125^{\circ}\text{C}$ based on voltage and properties
- ⚡ Newly discovered “Eddy Current” effects even at much lower temperatures would likely become THE limiting factor for 100Arms+ ripple current if not mitigated – Provisional Patent filed

DoE SBIR Discoveries



Melting damage due to newly discovered “Eddy Current” affect caused solely by the AC magnetic field around the high current conductors when there is no design consideration for mitigation.

DoE SBIR Conclusions

- ⚡ SBE Power Ring is likely to be capable of 200 – 250Arms up to cooling/ambient temperatures of 105°C
- ⚡ The DC Breakdown voltage of Polypropylene at elevated temperatures will likely limit the use of the Power Ring to 115 - 120°C even if at greatly reduced currents for DC Link applications
- ⚡ There is a “requirement” to take aggressive eddy current mitigation steps at currents in excess of 100Arms or localized, induced heating will become the failure at greatly reduced temperatures.