

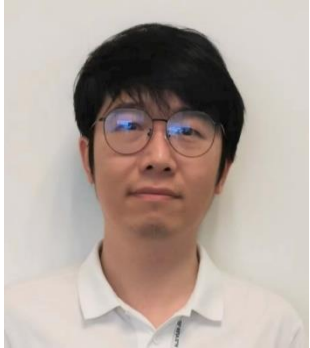
AGING BEHAVIOR AT 85°C AND 85% RH OF HIGH HEAT CAPACITORS FOR DC-LINK APPLICATIONS

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SABIC – SPECIALTIES

PCIM Asia Conference 2024



Yuan Zhou is a Lead Scientist with SABIC's Technology & Innovation Organization, with expertise in film & sheet making technology and extensive experiences in new applications. He is currently supporting SABIC's thin dielectric film developments.



1976
Company
established



Top 2
Chemical Brand Value*



29,000
Employees
around the world

38

US\$ bn
Net Sales



≈ 150
New products
each year



11,070
Global patent
filings



63
World-class
plants worldwide

ULTRA THIN DIELECTRIC FILMS FOR CAPACITORS

INDUSTRY CHALLENGE

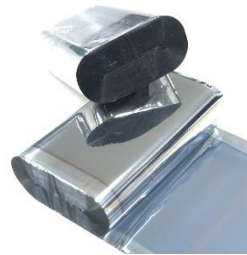
- Higher efficiency and increased range in EVs require efficient AC-DC inverter modules.
- SiC technology has shown potential for efficiency improvements when the module operates under high voltages and high temperatures up to 150°C.
- New generation capacitors operating at high temperatures and high voltages need to conform to industry requirements for damp heat aging (85°C and 85% relative humidity (RH)).

SABIC'S SOLUTION:

- New high heat film for DC-link capacitors: ELCRES™ HTV150A
- Ultra-thin dielectric film that can perform at temperatures up to 150°C
- Capacitors made with HTV150A 5 & 3μm films pass 1000 hours of aging at 85°C/ 85% RH, under applied voltage of 800V (for 5μm) and 500V (for 3μm).



Ultrathin Film rolls
(5 & 3μm x 5000m)



Capacitor windings



Bulk Capacitor
(For Power Module)



NEW GENERATION DIELECTRIC FILM (ELCRES™ HTV150A)

FEATURES

- Stable high D_k and low D_f up to 150°C and 100 kHz
- High breakdown strength from -40°C to 150°C
- Good self-healing
- Stable capacitance, IR, and D_f at 150°C over 2000 hours in capacitor life-test

DIFFERENTIATORS

- Performance at high temperature and high frequency
- Surety of supply
- Potential for use in wide band-gap (WBG) semiconductors

POTENTIAL BENEFITS

- Supports more reliable operation at elevated temperatures
- Co-location within power train improving efficiency
- Enabling the advantages of WBG chips to be fully utilized
- Downsizing or elimination of active cooling systems

▶ ELCRES™ HTV150A film offers high performance solutions for next generation systems and opportunity for system cost-out

NEW GENERATION FILM: POTENTIAL CAPACITOR APPLICATIONS

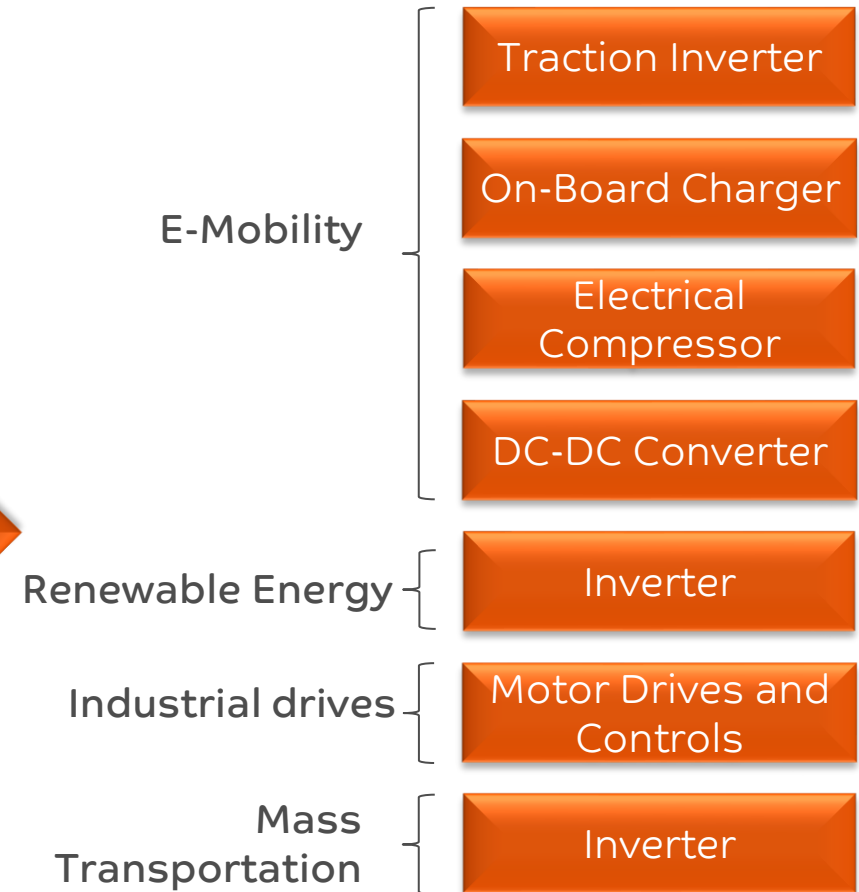
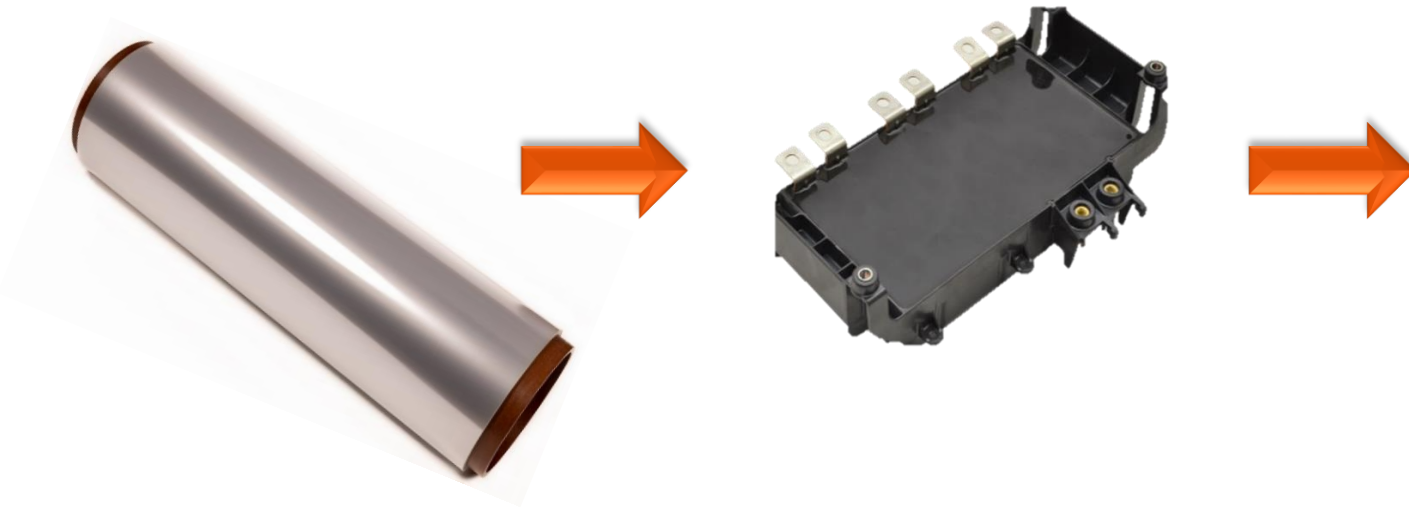
HIGH HEAT FILM:

Grade name: ELCRES™ HTV150A film

Thickness: 5μm & 3μm

Dimensions: 620 mm (W) x 5000* m (L)

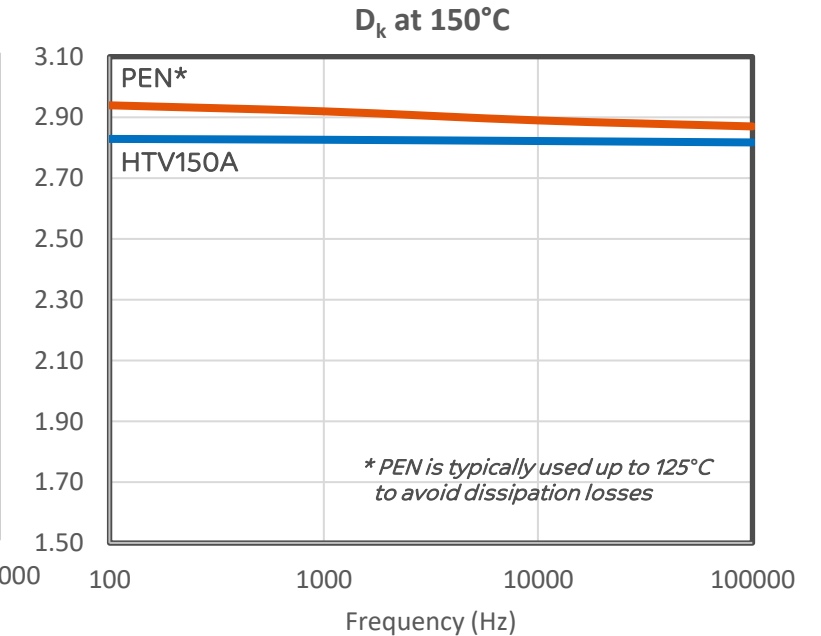
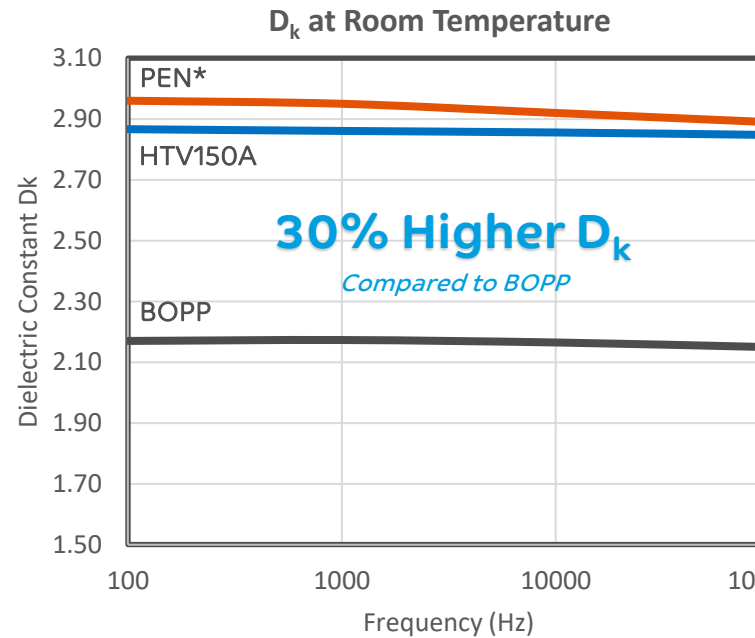
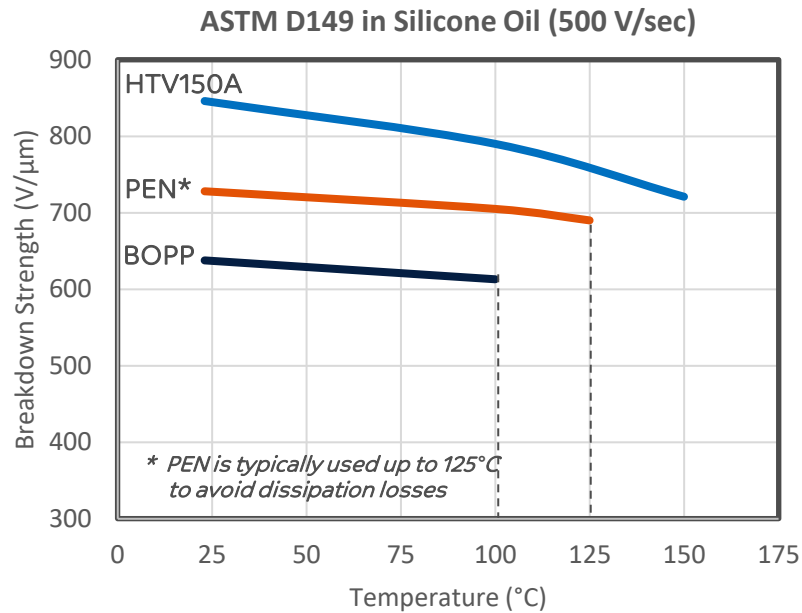
**10,000m rolls coming soon*



➤ ELCRES™ HTV150A film is available for multiple applications requiring high temperature resistance during processing or operation

ELCRES™ HTV150A FILM CHARACTERISTICS

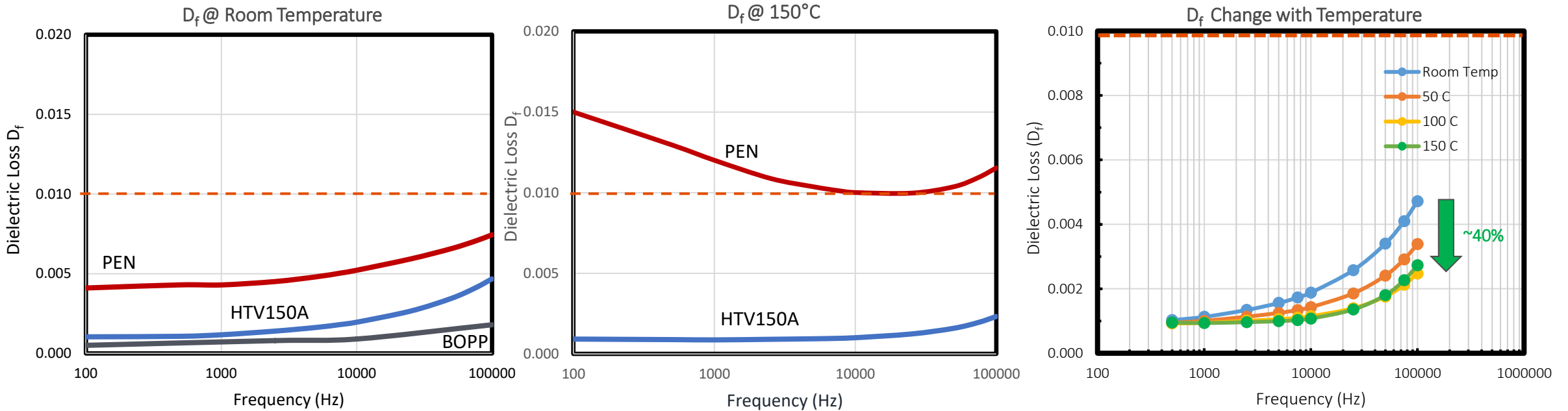
FILM BREAKDOWN STRENGTH (BDS) & DIELECTRIC CONSTANT (D_k)



➤ ELCRES™ HTV150A film maintains BDS and D_k performance at elevated temperatures and high frequencies

ELCRES™ HTV150A FILM CHARACTERISTICS

FILM DIELECTRIC LOSS D_f



➤ **ELCRES™ HTV150A film offers lower dielectric losses at higher temperatures and frequencies**

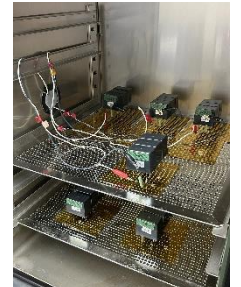
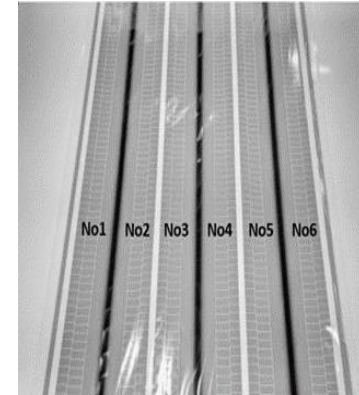
DAMP HEAT AGING (85°C / 85% RH) - ELCRES™ HTV150A FILM – 5 & 3 μm

- ELCRES™ HTV150A films: 5μm & 3μm
- Advanced segmented metallization
- 20Ω/ 5Ω body/ heavy-edge resistivity
- 30mm width, flattened elements
- 6 capacitors per test condition
- Exposure according to JEITA AEC-Q200 (REV D)

	Segmented metallization	Applied Voltage	Target Exposure
5 μm	5 μF	0, 500, 800V	≥1000 hours
3 μm	10 μF	0, 300, 500V	≥1000 hours

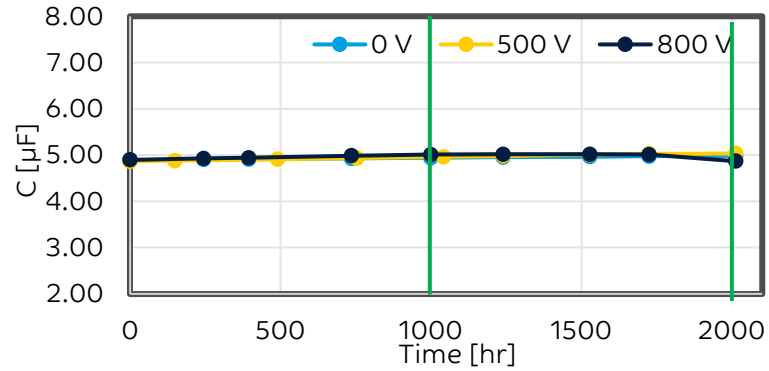
- Monitored:
 - Capacitance change ΔC%
 - Insulation Resistance IR
 - Dissipation loss Tan δ

➤ Passing damp heat test on component level increases confidence for passing at a system level

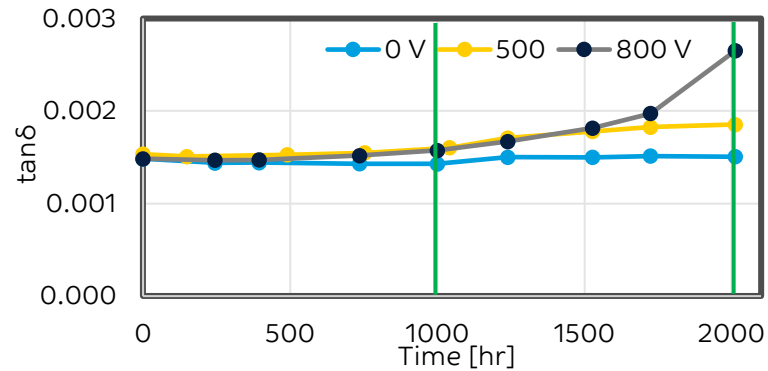


DAMP HEAT AGING (85°C/ 85% RH) - 5 μ m FILM

2000
hours

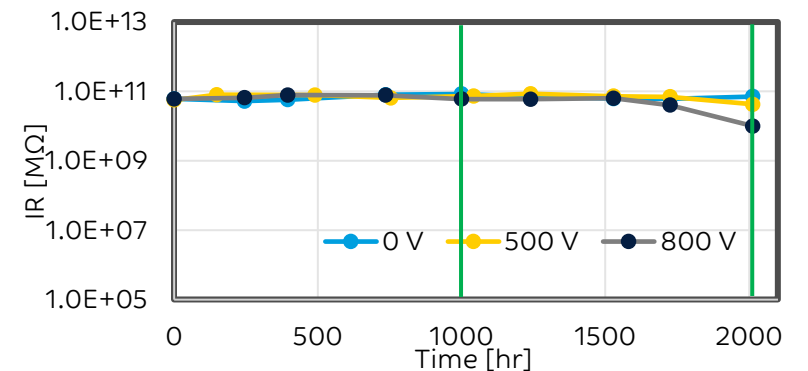


Stable C



Stable Tan δ

(Less than 2X initial value)

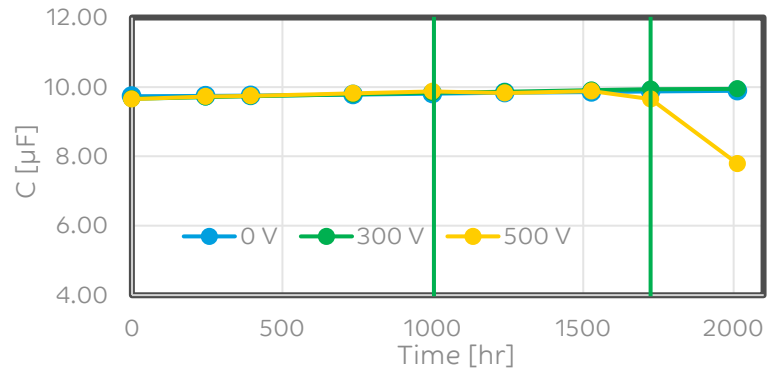


Stable IR

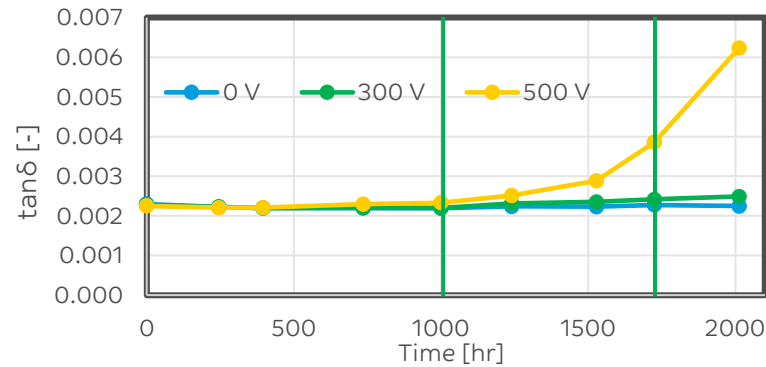
➤ ELCRES™ HTV150A 5 μ m films exceed 1000-hour damp heat requirements

DAMP HEAT AGING (85°C/ 85% RH) - 3 μ m FILM

1750
hours

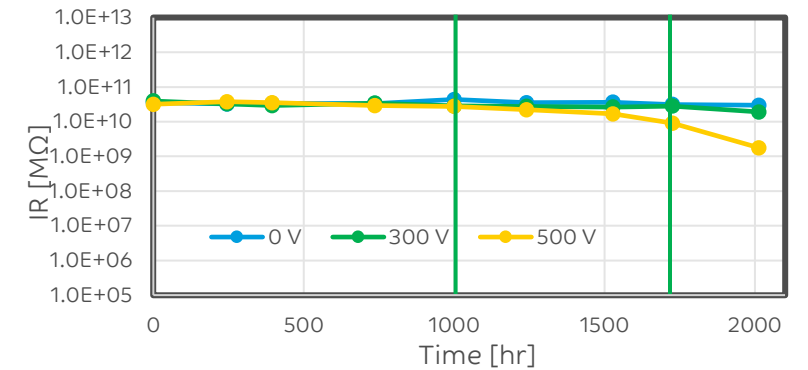


Stable C



Stable Tan δ

(Less than 2X initial value)



Stable IR

➤ ELCRES™ HTV150A 3 μ m films exceed 1000-hour damp heat requirements

CONCLUDING REMARKS

- High-heat ELCRES™ HTV150A dielectric films used successfully to build high temperature capacitors.
- Capacitors exceeded 1000-hour damp heat aging (85°C and 85%RH):
 - 5μm reached 2000 hours at 0, 500, 800V
 - 3μm reached 2000 hours at 0, 300V
 - 3μm reached 1750 hours at 500V
- Capacitors made with HTV150A films reached 2000 hours of aging at 85°C/ 85% RH.
- Stable ΔC , $\tan \delta$, and IR with little or no change over the 1000-hour test duration.
- Meeting industry performance requirement on the component level increases confidence in employing the high heat capacitors in current and new AC-DC inverter designs for electric vehicles.



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