pcim ASIA

150°C Capacitors for DC-Link Applications

Dr. Adel Bastawros, SABIC SPECIALTIES

Shenzhen, August 2024

WHO ARE WE?

1976
Company established

29,000
Employees around the world

38
US$ bn
Net Sales

Top 2
Chemical Brand Value*

≈ 150
New products each year

11,070
Global patent filings

63
World-class plants worldwide

1950
Company established

Leader
Film capacitors
Energy Storage

5,400
Employees around the world

200
JPY bn
Net Sale

Innovative products
Vehicle electrification

R&D
Aggressive investments

28
Group companies

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ULTRA THIN DIELECTRIC FILMS FOR HIGH HEAT CAPACITORS

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INDUSTRY CHALLENGE

- For increased EV performance, OEMs require powertrain and capacitors to operate at higher heat and power levels
- Incumbent films, without active cooling, can operate only up to 105°C. Other higher temperature films may reach 125°C , but at significant dielectric losses.
- Novel, thin dielectric films, capable of operating at higher temperatures and voltages are needed

SOLUTION:

SABIC:

- New high heat film for DC-link capacitors: ELCRES™ HTV150A
- High heat materials to support superior performing xEVs

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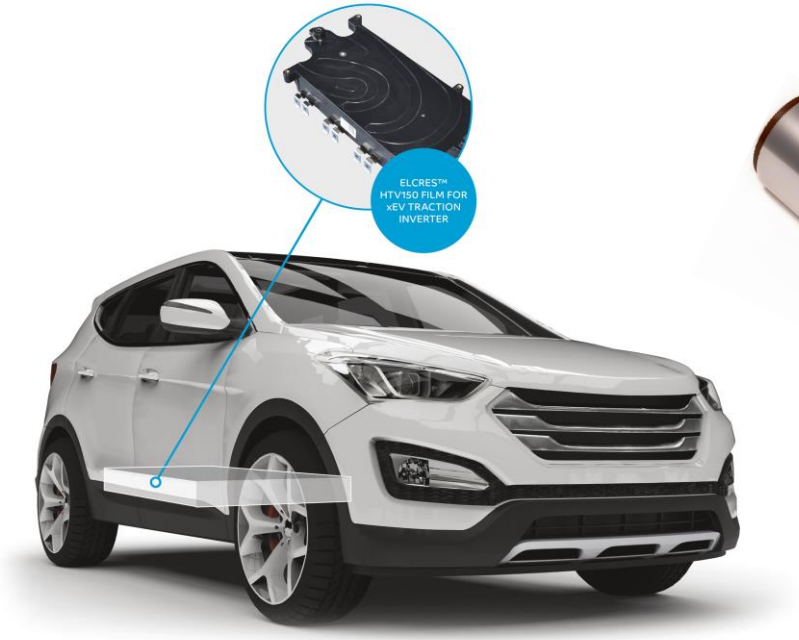
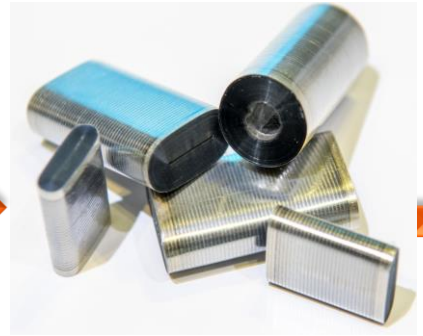
- Film capacitors that can perform at temperatures up to 150°C
- Higher power density and voltage of EV traction inverters





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NEW GENERATION HIGH TEMPERATURE HIGH VOLTAGE CAPACITOR FILM

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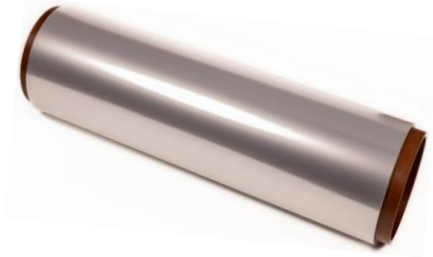
ELCRES™ HTV150A

2021 R&D 100 WINNER



ELECTRICAL CHARACTERISTICS

- 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 2000hrs of life-testing

POTENTIAL BENEFITS

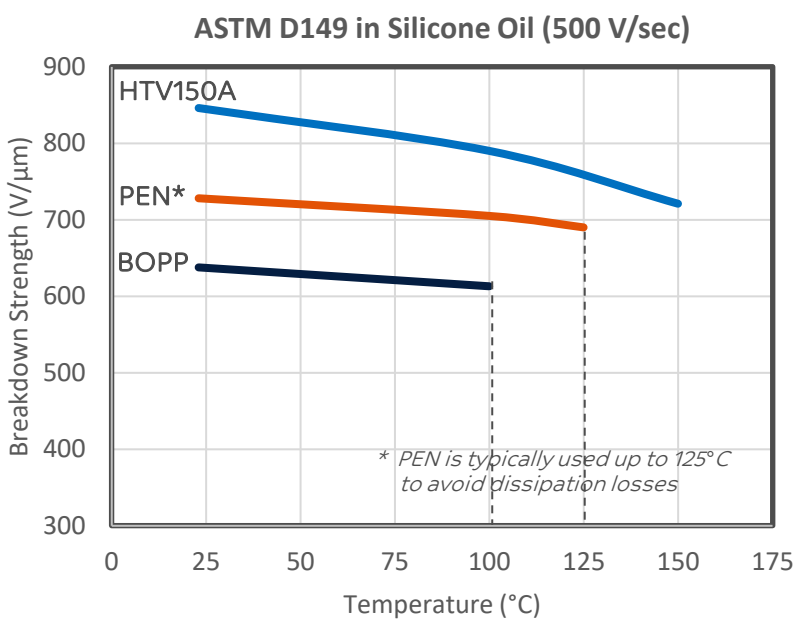
- Supports more reliable operation at elevated temperatures
- Co-location within power train improving efficiency
- Enabling the advantages of WBG chips to be fully utilized
- Downsizing or elimination of active cooling systems

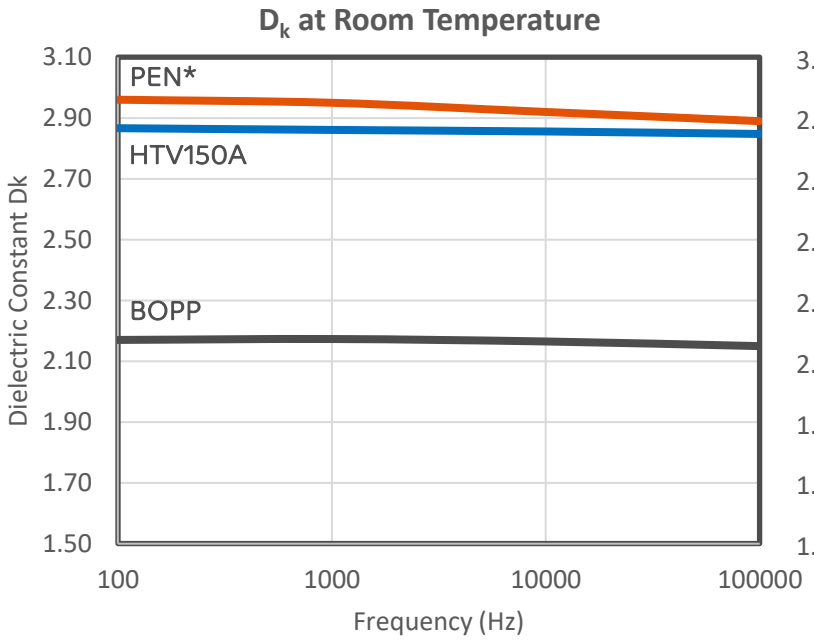
E-Mobility	Traction Inverter
	On-Board Charger
	Electrical Compressor
	DC-DC Converter
Renewable Energy	Inverter
Industrial drives	Motor Drives and Controls
Mass Transportation	Inverter

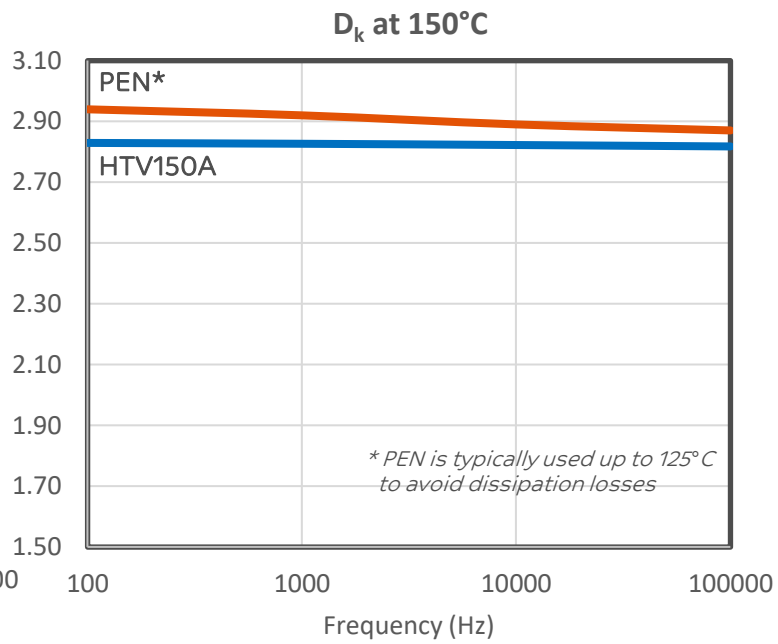
ELCRES™ HTV150A film is a candidate for applications requiring high temperature resistance during processing or operation

ELCRES™ HTV150A FILM CHARACTERISTICS

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



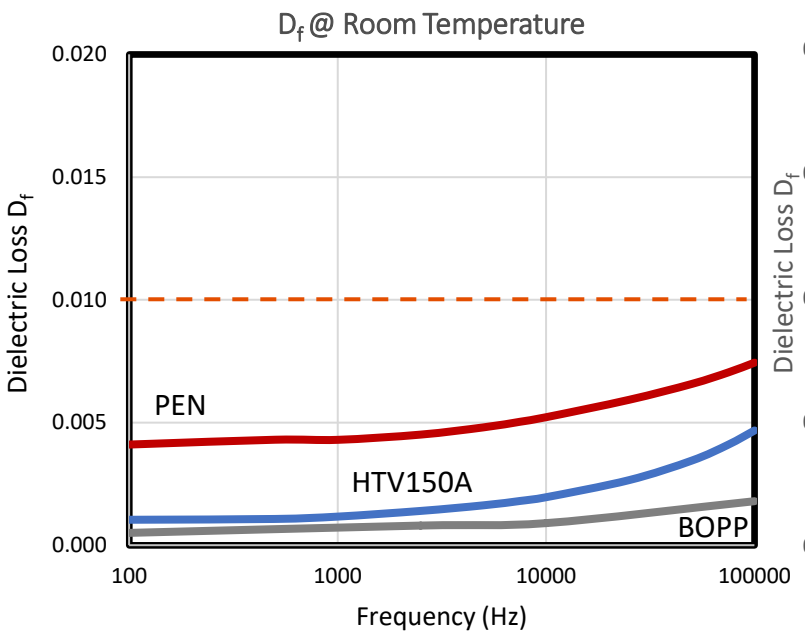


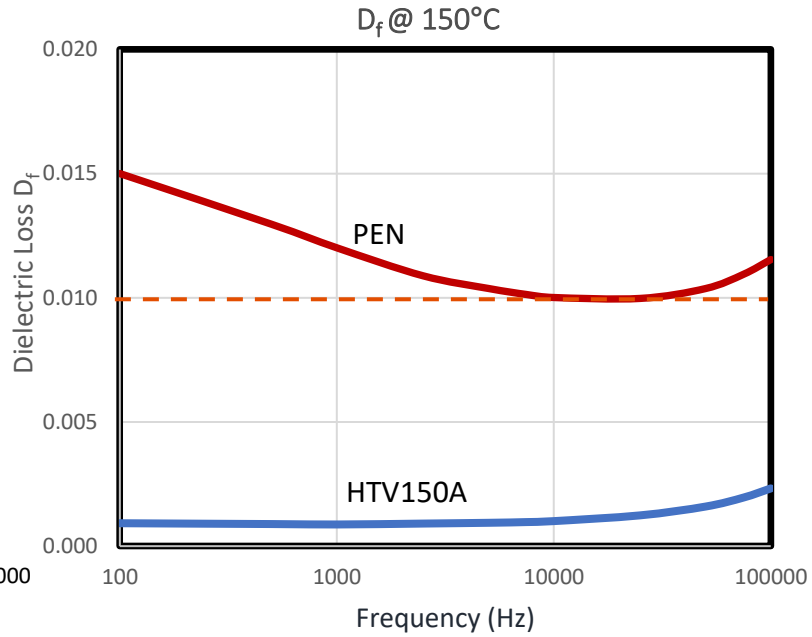


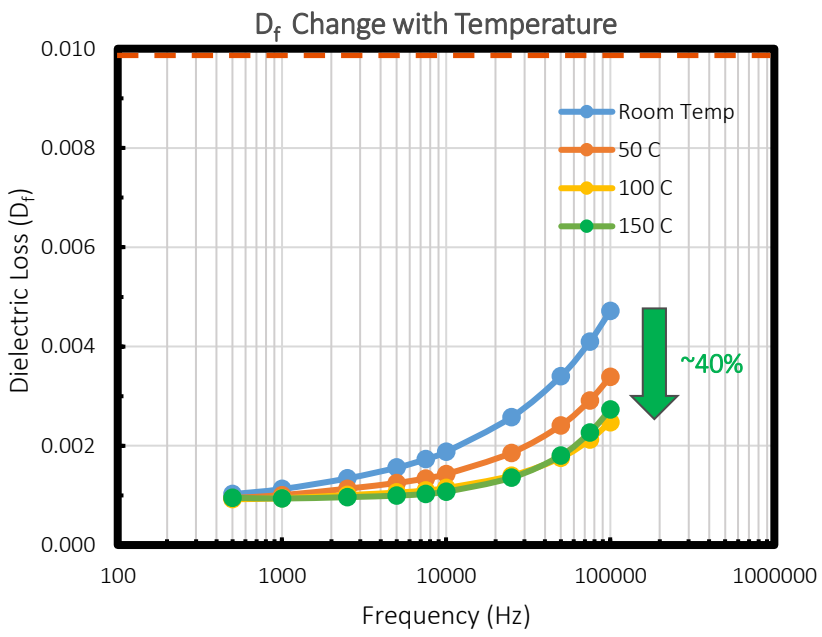
ELCRES™ HTV150A film maintains BDS and D_k performance at elevated temperatures and high frequencies

ELCRES™ HTV150A FILM CHARACTERISTICS

FILM DIELECTRIC LOSS D_f







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

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HIGH HEAT CAPACITOR BUILDS

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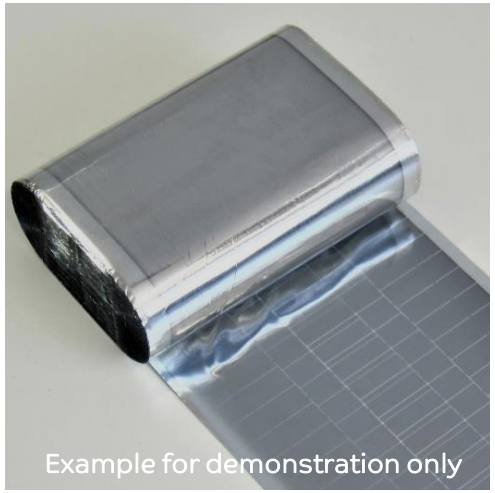
- ELCRES™ HTV150A films: 5µm & 3µm
- Advanced segmented metallization
- 20Ω/ 5Ω body/ heavy-edge resistivity
- Flattened elements
- 10 capacitors per condition
  (Temperature, Voltage, film gauge)
- Monitored:
  - Capacitance change ΔC%
  - Insulation Resistance IR
  - Dissipation loss Tan δ
  - Equivalent Series resistance ESR

	Segmented metallization
5 µm	10 µF
3 µm	19 µF



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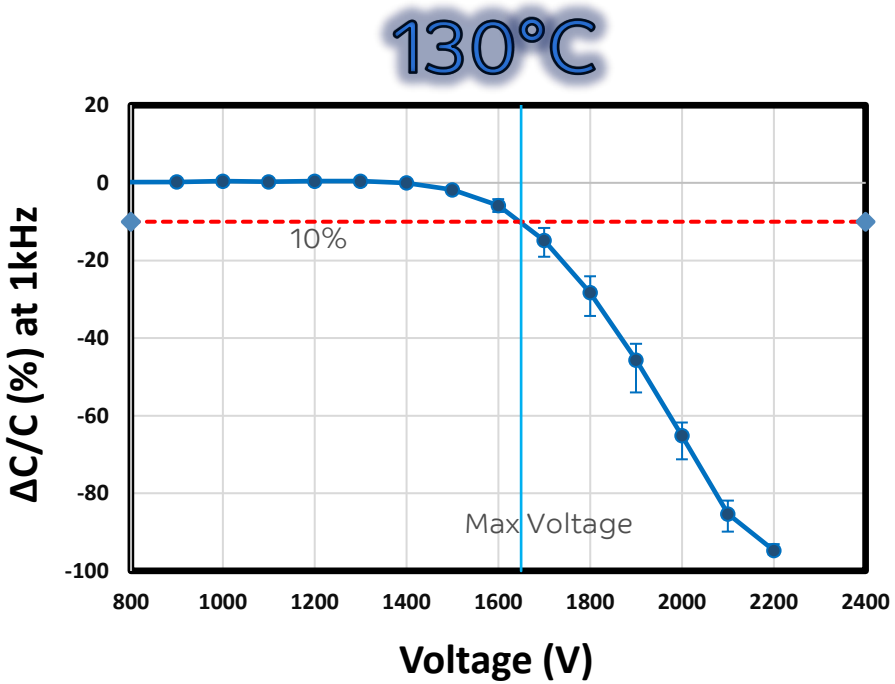
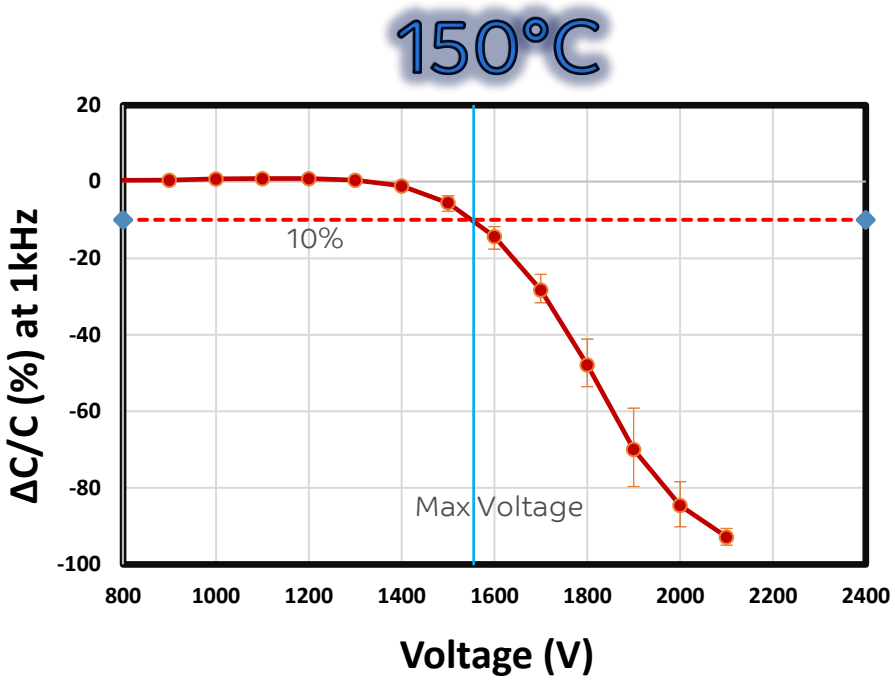
ELCRES™ HTV150A films are compatible with existing downstream metallization, slitting and capacitor building technologies

CAPACITOR VOLTAGE STRESS TEST (5µm film*)



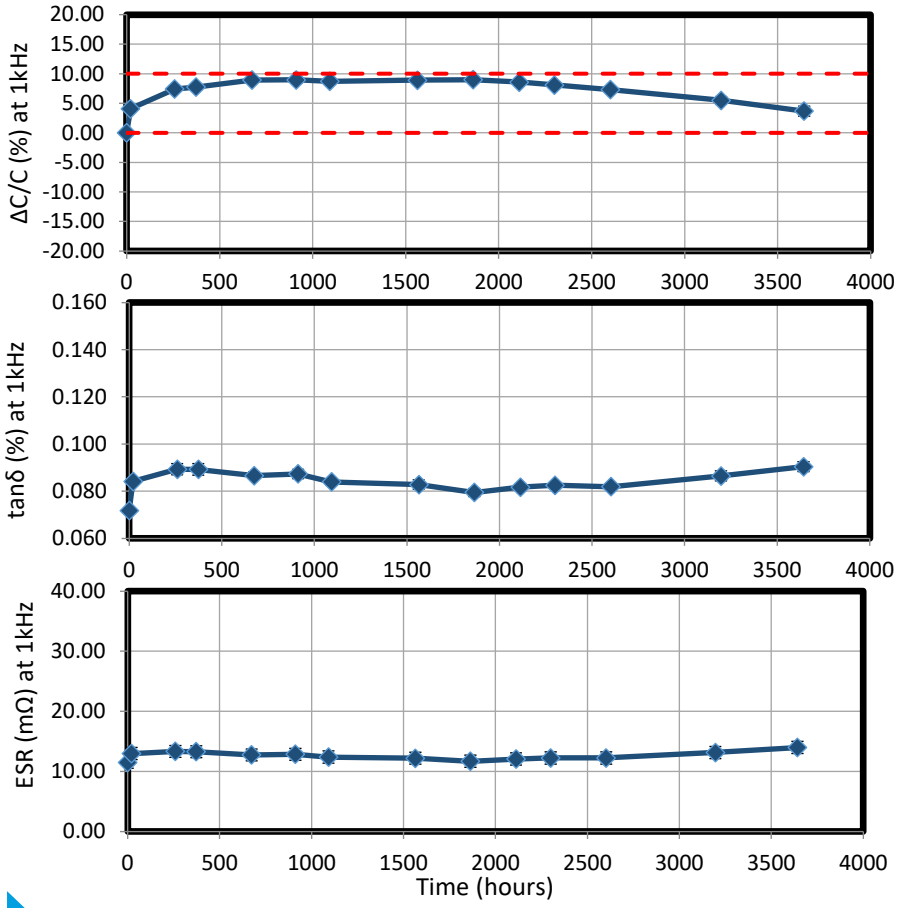


For 10% Drop in C	Max Voltage	Operating Voltage
@ 130°C	1650V	1000V
@ 150°C	1550V	900V

For **3µm film capacitors, Operating Voltage is **600V** @150° C*

RELIABILITY LIFE TESTING OF HIGH HEAT CAPACITORS (5µm film)

130°C/ 1000V/ 3600 hours



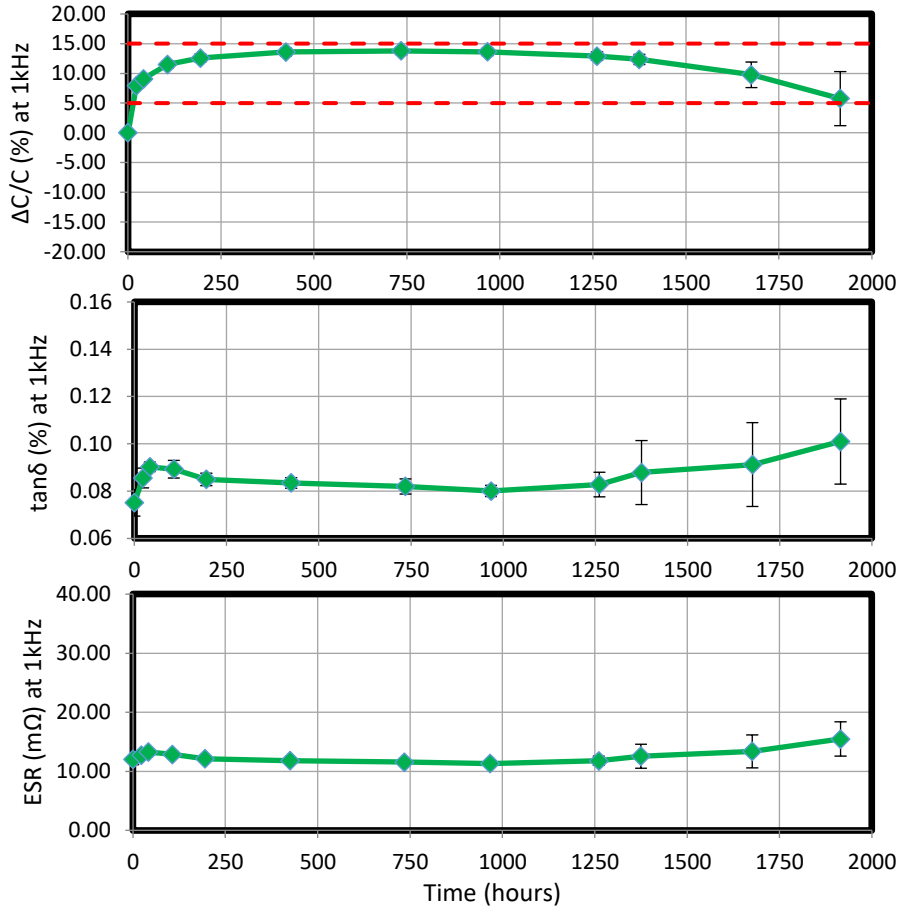
ΔC < 5%

Stable Tan δ

(Less than 2X initial value)

Stable ESR

150°C/ 900V/ 2000 hours



High heat capacitors made with ELCRES™ HTV150A 5µm film pass life testing

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CONCLUDING REMARKS

- High-heat ELCRES™ HTV150A dielectric films used successfully to build high temperature capacitors.
- 5µm-based capacitors passed accelerated reliability life testing:
  - @ 130°C under 1000V for 3600 hours and
  - @ 150°C under 900V for 2000 hours
- 3µm-based capacitors reached 1500 hours @ 150°C under 600V *(test restarted due to high initial gain).*
- Capacitance change ΔC remained within 5%
- tan δ remained lower than 2x the starting value
- IR & ESR remained stable
- Capacitors made with HTV150A film are well positioned to help realizing full benefits of SiC and GaN MOSFETs when used in AC-DC inverters for EV applications

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