

CHEMISTRY THAT MATTERS™



# Reliability of **HTV150A** Films for High Temperature & High Voltage DC-Link Capacitors

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Adel Bastawros, Ph.D., is a Chief Scientist with SABIC Specialties Technology & Innovation Organization, with extensive materials background and research focus on emerging technologies and functional materials. He is currently leading 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

# OUR PORTFOLIO AND GLOBAL MEGATRENDS



# 应用于高温电容器的超薄介电薄膜

## ULTRA THIN DIELECTRIC FILMS FOR HIGH HEAT CAPACITORS

### INDUSTRY CHALLENGE 行业挑战

- Increase EV performance. 提高电动汽车的性能.
- Use high heat powertrain components (e.g., capacitors) 使用耐高温的动力系统元器件 (例如, 电容器)
- Current capacitor films are limited to 105°C. 现有电容器薄膜使用温度上限为105°C.
- Other films may reach 125°C, but losses are high. 有些薄膜可以耐125°C, 但是损耗较高.
- New films that can operate at higher temperatures (150°C) and higher voltages are needed. 需要能够在高温 (150°C) 和高压下使用的新型电容薄膜

### SOLUTION 解决方案:

#### SABIC:

- New high heat film for DC-link capacitors: ELCRES™ HTV150A 应用于DC-Link电容器的新型耐高温薄膜 : ELCRES™ HTV150A
- High heat materials to support superior performing xEVs 耐高温材料支持高性能电动汽车

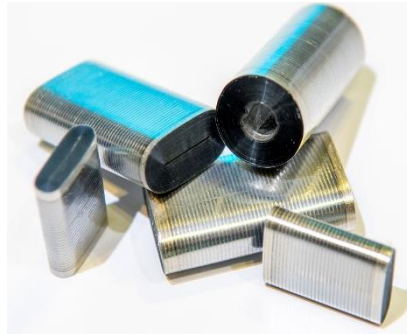
#### Nichicon:

- Film capacitors that can perform at temperatures up to 150°C 能够在高达150°C温度下工作的薄膜电容器
- Higher power density and voltage of EV traction inverters 更高功率密度和工作电压的电动汽车牵引逆变器

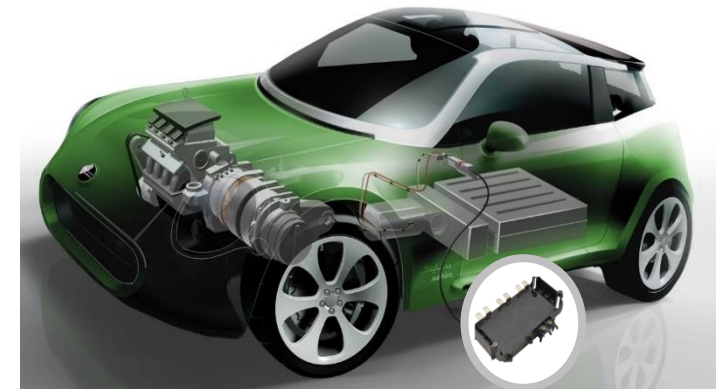


سابك  
sabic

HTV150A Film rolls, 5 & 3µm x 5000m



nichicon

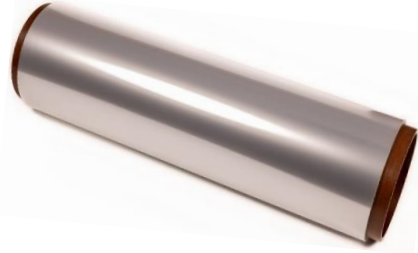


## 高温薄膜电容器解决方案

# 新一代高温高压电容薄膜

## NEW GENERATION HIGH TEMPERATURE HIGH VOLTAGE CAPACITOR FILM

ELCRES™ HTV150A



### ELECTRICAL CHARACTERISTICS 电气特性

- 在 150°C 和 100kHz 条件下具有高  $D_k$  和低  $D_f$
- -40-150°C 温度范围内，有较高的击穿强度
- 良好的自愈性
- 通过2000小时150°C长期寿命测试

### POTENTIAL BENEFITS 潜在优势

- 支持在更高的环境温度下工作
- 和传动系统放置一起以提升效率
- 能够充分发挥 SiC & GaN 的优势
- 缩小或消除主动冷却系统

E-Mobility

Traction Inverter

On-Board Charger

Electrical  
Compressor

DC-DC Converter

Renewable Energy

Inverter

Industrial drives

Motor Drives and  
Controls

Mass  
Transportation

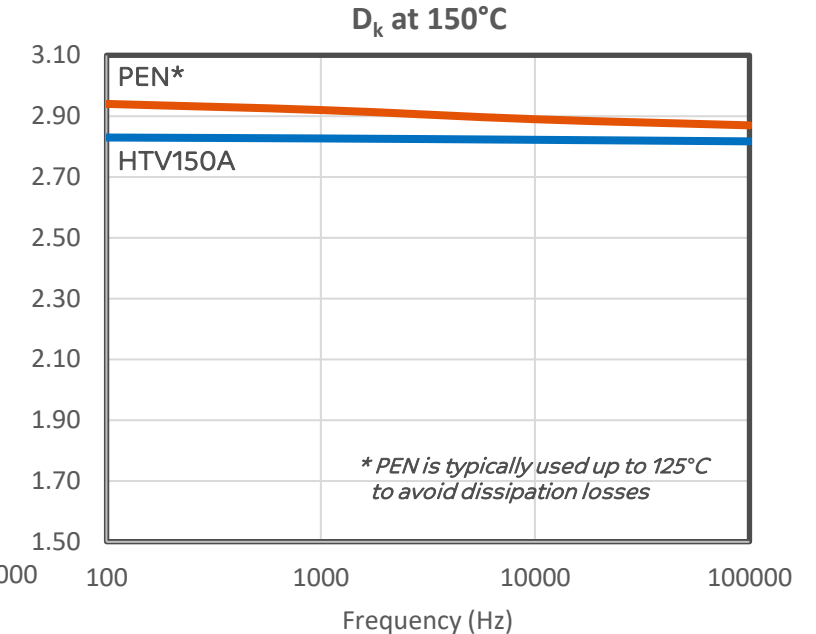
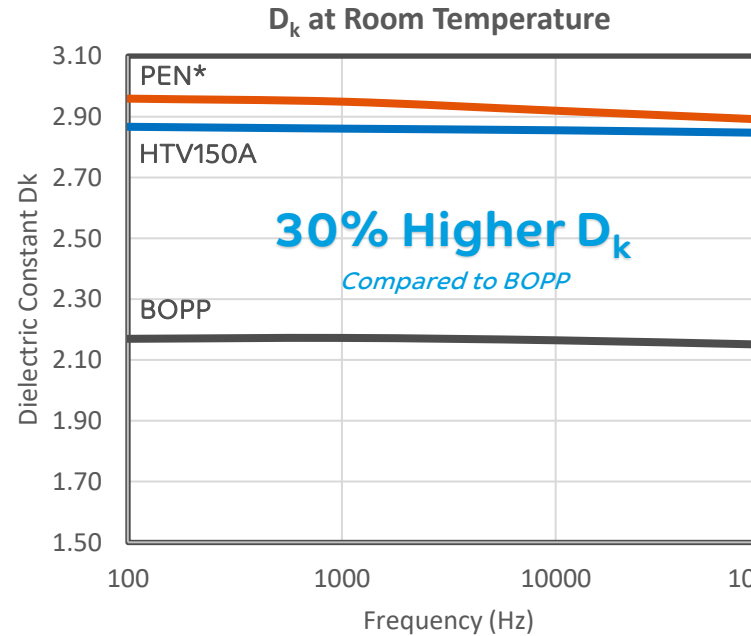
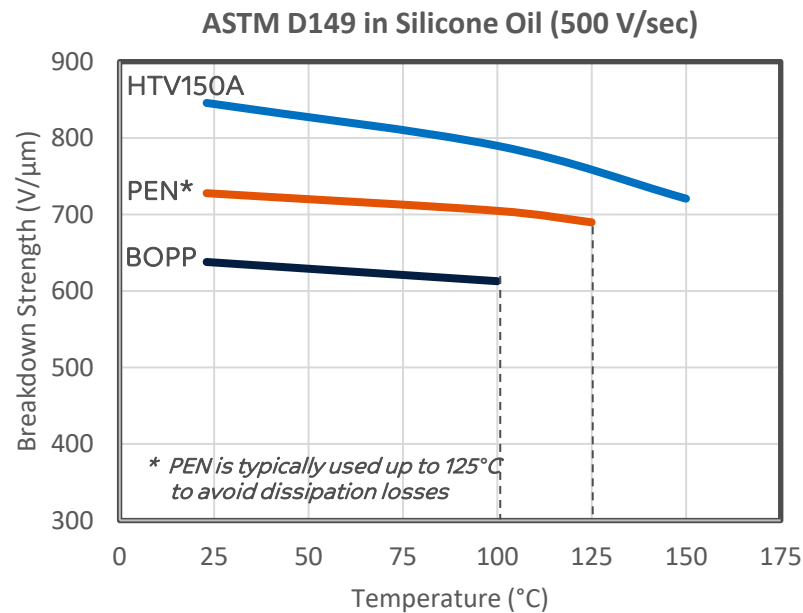
Inverter

➤ ELCRES™ HTV150A 薄膜适用于加工或操作过程中需要高温性能的应用场景

# ELCRES™ HTV150A 薄膜的性能

## ELCRES™ HTV150A FILM CHARACTERISTICS

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

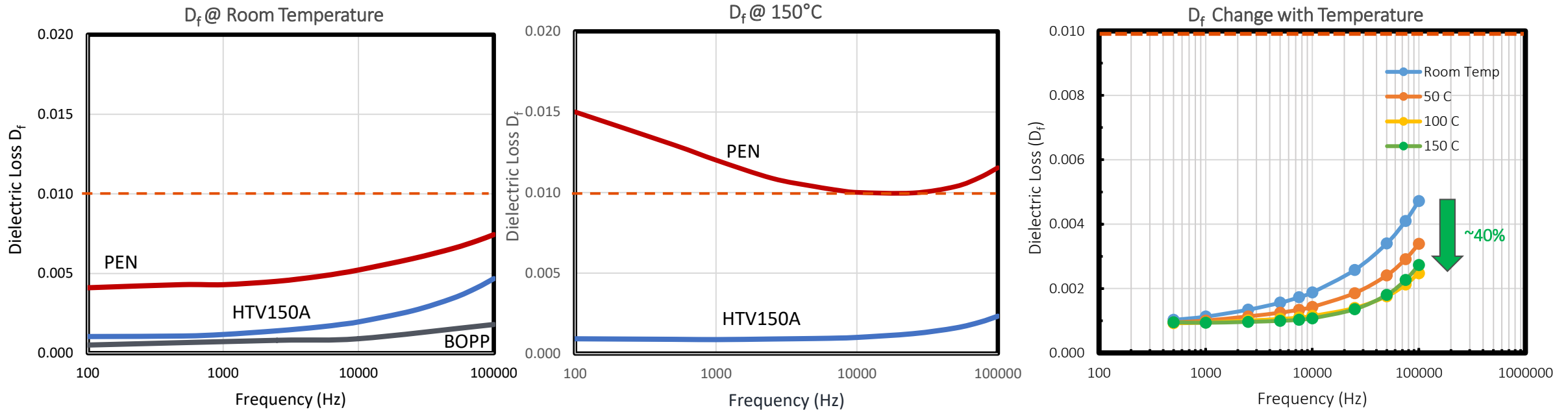


➤ ELCRES™ HTV150A film maintains BDS and  $D_k$  performance at 150°C and high frequencies  
 ELCRES™ HTV150A 薄膜在 150°C 和高频率条件下仍保持稳定的击穿强度和 $D_k$

# ELCRES™ HTV150A 薄膜的性能

## ELCRES™ HTV150A FILM CHARACTERISTICS

### FILM DIELECTRIC LOSS $D_f$ 薄膜介电损耗 $D_f$



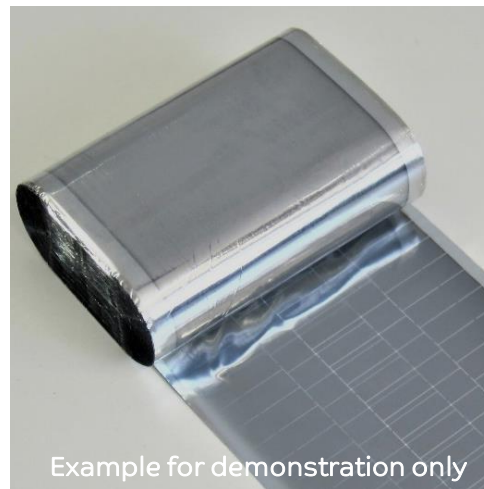
➤ ELCRES™ HTV150A film offers lower dielectric losses at higher temperatures and frequencies  
ELCRES™ HTV150A 薄膜在较高的温度和频率下仍保持较低的介电损耗

# 尼吉康公司制作的高温薄膜电容器

## BUILDING HIGH HEAT CAPACITOR BY **nichicon**

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

	Segmented metallization
5 μm	10 μF
3 μm	19 μF



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**nichicon**



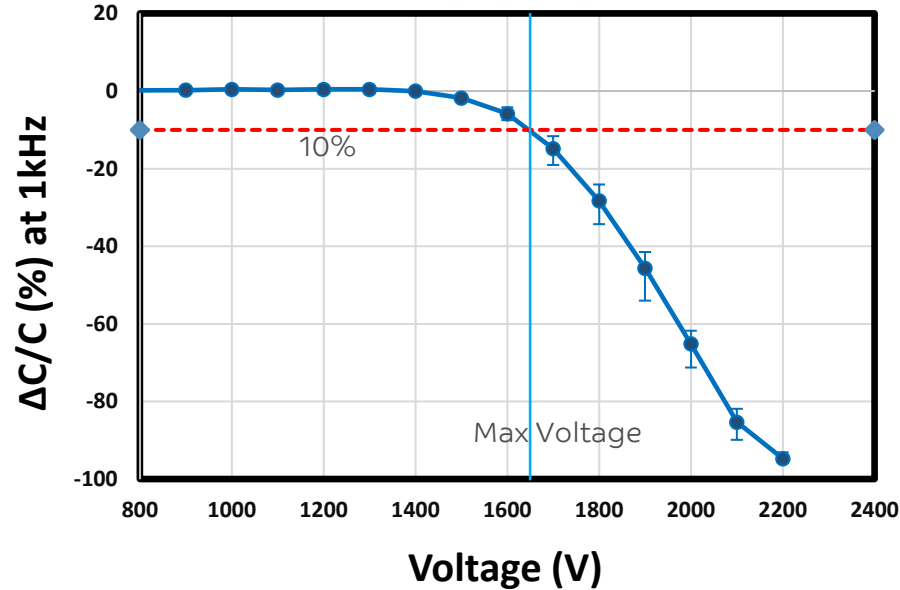
➤ HTV150A films are compatible with metallization, slitting and capacitor building technologies  
ELCRES™ HTV150A 薄膜能够兼容现有的金属化，分切和电容器制作工艺



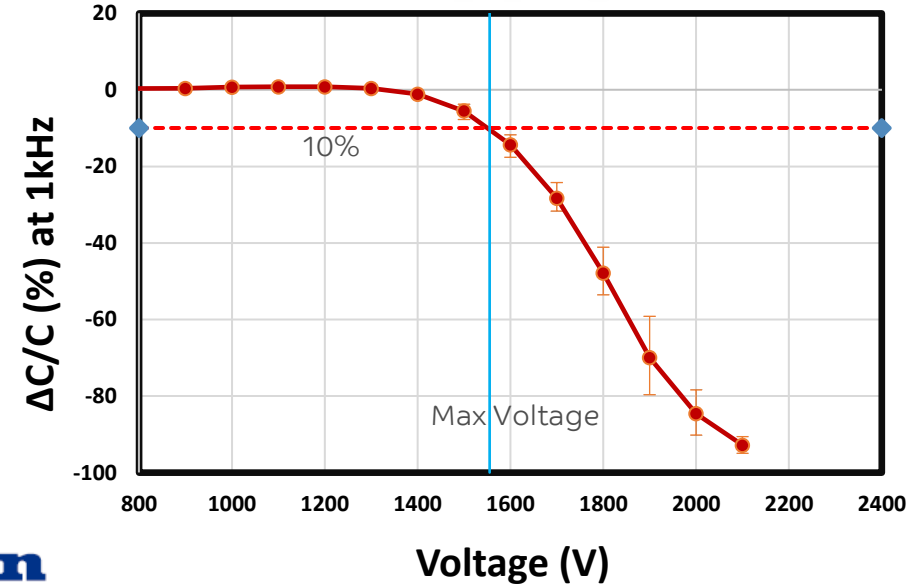
# 电容器升压测试 (5μm 薄膜)

## CAPACITOR VOLTAGE RAMP UP TEST (5μm film)

130°C



150°C



**nichicon**

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

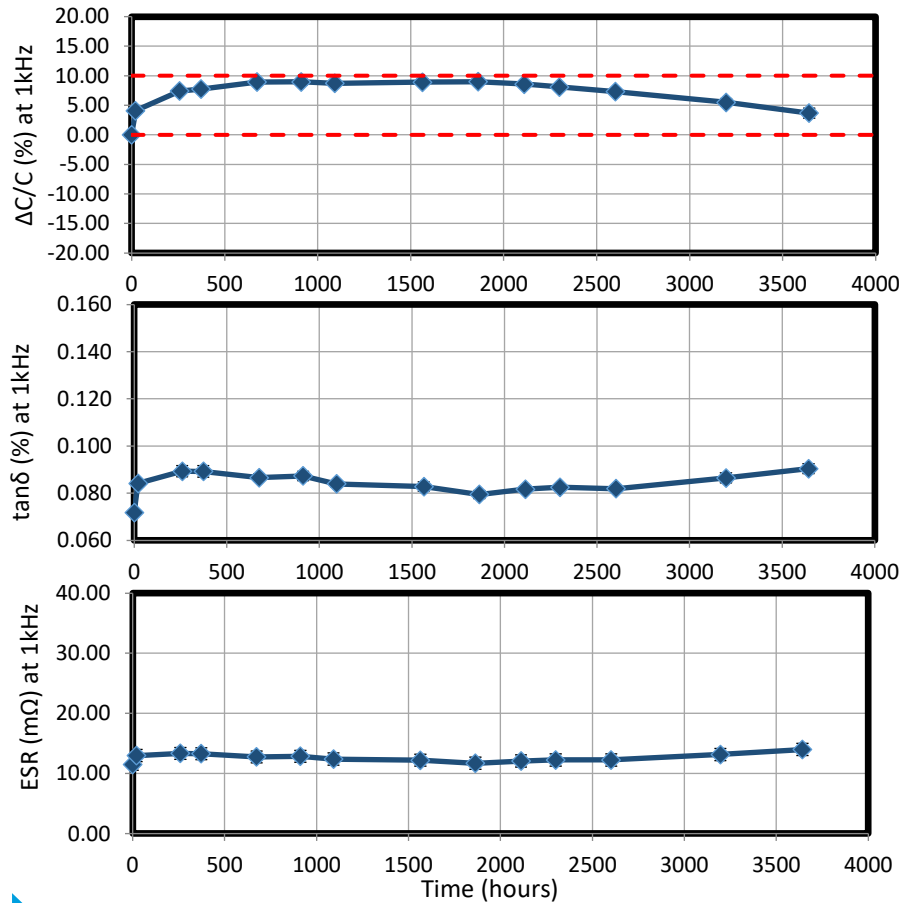
\*Operating Voltage = Max. Voltage x Safety Factor

**通过升压测试来决定工作电压**

# nichicon 高温电容器长期寿命测试(5 $\mu$ m 薄膜)

## RELIABILITY LIFE TESTING OF HIGH HEAT CAPACITORS (5 $\mu$ m film)

130°C/1000V/3600 hours

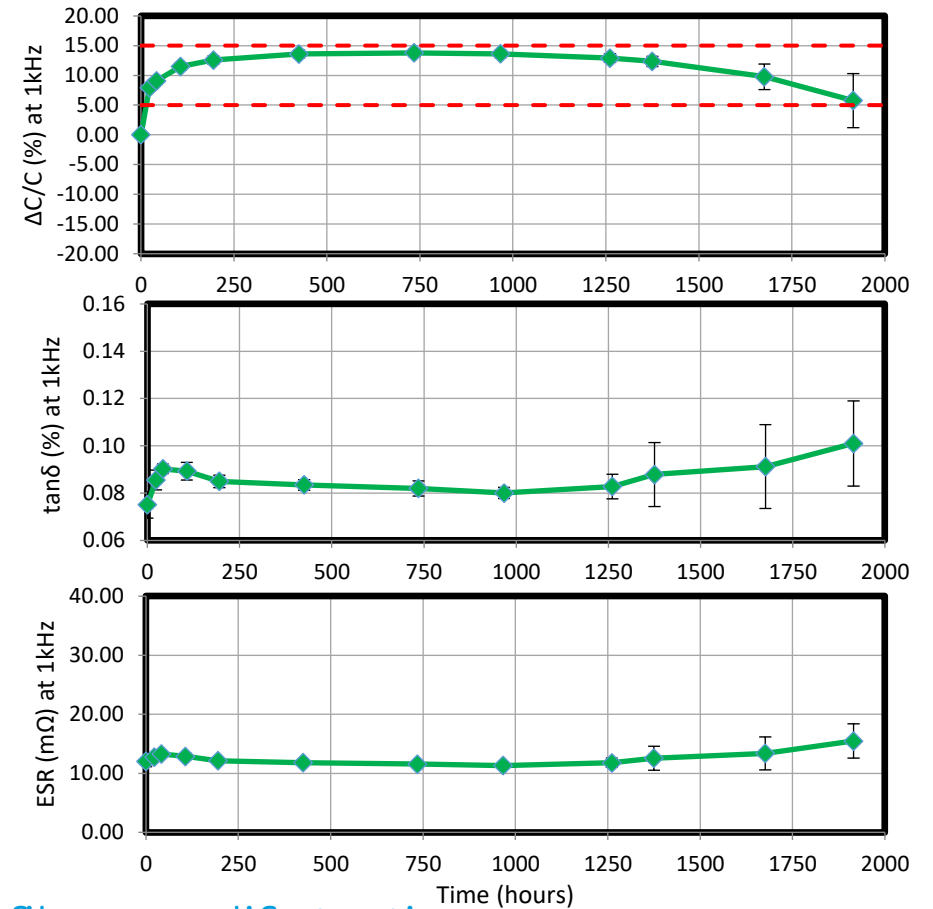


$\Delta C < 5\%$

Stable  $\tan\delta$   
(Less than 2X initial value)

Stable ESR

150°C/900V/2000 hours



High heat capacitors made with ELCRES™ HTV150A 5 $\mu$ m film pass life testing  
使用 ELCRES™ HTV150A 5 $\mu$ m 薄膜制作的高温电容器通过长期寿命测试

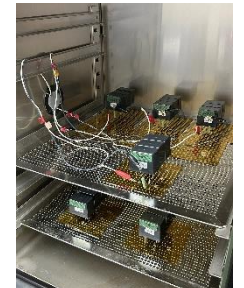
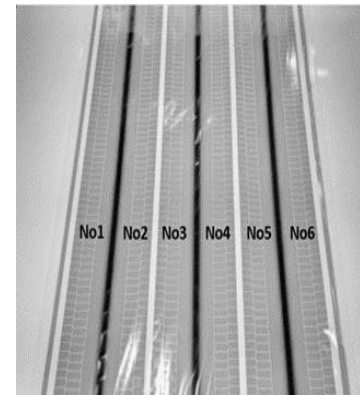
# 湿热老化测试 (85°C / 85% RH) - ELCRES™ HTV150A 薄膜 - 5 & 3 μm

## 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
- 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  $\Delta C\%$
  - Insulation Resistance IR
  - Dissipation loss Tan  $\delta$

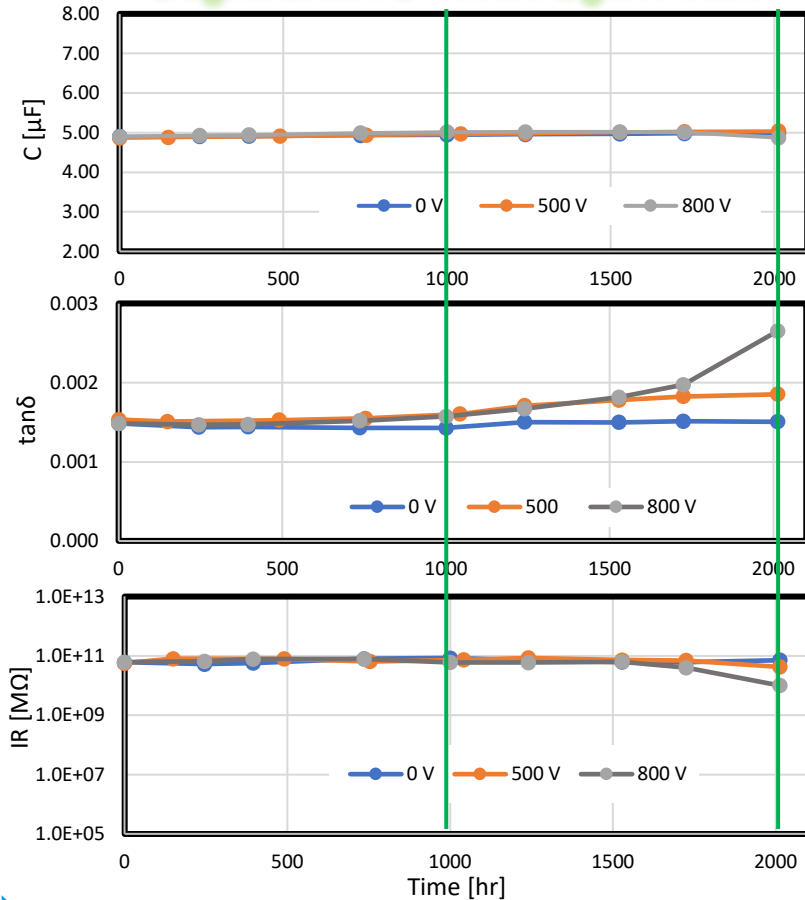


▶ Passing damp heat test on component level increases confidence for passing at a system level  
 薄膜通过了元器件级别的湿热老化测试，从而增加了其通过系统测试的信心

# 湿热老化测试 (85°C / 85% RH) - ELCRES™ HTV150A 薄膜电容器

## DAMP HEAT AGING (85°C/ 85% RH) - ELCRES™ HTV150A FILM CAPACITORS

### Capacitors with 5µm film



2000  
hours

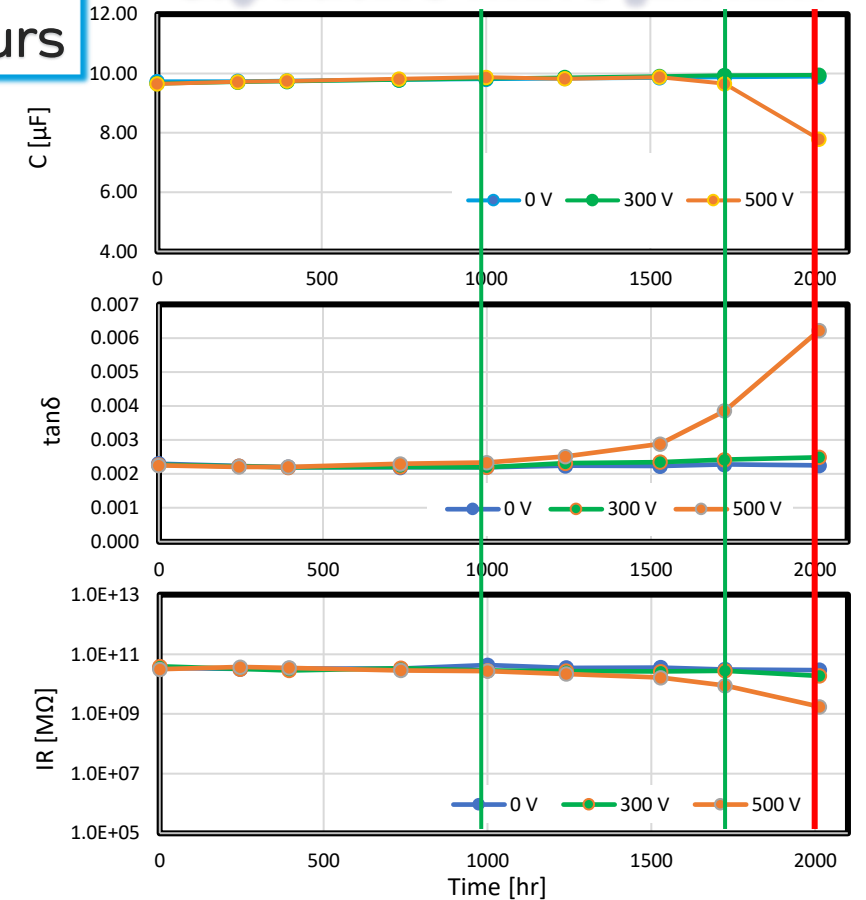
Stable C

Stable Tan δ  
(Less than 2X initial value)

Stable IR

1750  
hours

### Capacitors with 3µm film



ELCRES™ HTV150A 3&5 µm films exceed 1000-hour damp heat requirements  
ELCRES™ HTV150A 3&5 µm 薄膜超过1000 小时湿热老化要求

## CONCLUDING REMARKS

- High-heat ELCRES™ HTV150A dielectric films used successfully to build high temperature capacitors.

**耐高温ELCRES™ HTV150A 介电薄膜已经成功制作成高温电容器**

- Capacitors passed accelerated reliability life testing at

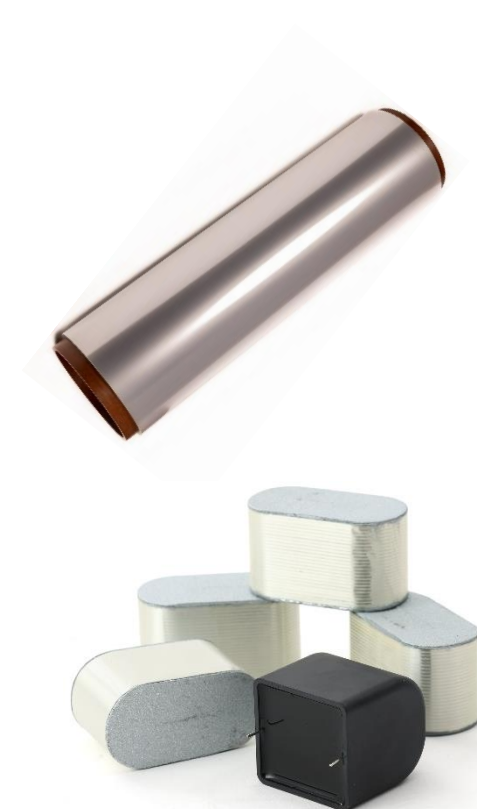
**电容器在通过了长期寿命测试**



- 5μm @ 130°C under 1000V for 3600 hours
  - 5μm @ 150°C under 900V for 2000 hours
  - 3μm @ 150°C under 600V (test restarted at 1500hours due to high initial gain)
- Capacitors exceeded 1000-hour damp heat aging (85°C and 85%RH):  
**电容器通过了超过1000小时的湿热老化测试 (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
- Capacitance change  $\Delta C$  remained within 5%
- $\tan \delta$  remained lower than 2x the starting value
- IR & ESR remained stable

**电容值变化率小于5%  
tan δ 保持小于2倍初始值  
IR & ESR 保持稳定**

**采用 HTV150A 薄膜制成的电容器能够帮助电动汽车 AC-DC 逆变器充分发挥 SiC 和 GaN MOSFET 的全部优势**



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