Failure Modes of High Voltage Film Capacitors
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Everything you wanted to know about failure modes in high voltage film caps but were afraid to ask.

• What are some common causes for failure in HVFCs?
• What is a typical process for analyzing failure modes of HVFCs?
• What are the visual indications and causes of specific failure modes in HVFCs?
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What are some common causes for failure in HVFCs?
Misapplication and Environmental Causes

- $Va>Vr$: Overvoltage
- $Ta>Tr$: Ambient temperature too high
- AC voltage applied to DC rated part
- $I_{RMS}$: Ripple current exceeds capability
- $dV/dt$: Too high pulse current
- Moisture
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Poor Design for Intended Application

• Too thin dielectric for \( V_r \)
• Wrong metallization type for application
  • Zinc, aluminum, alloy?
  • Too high or low ohms per square metallization
  • Wrong metallization pattern for application
• For AC application, part not designed to prevent or inhibit corona
• Design not proven with life test
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Poor Processing

• Loose winding
• No burn-off
• Poor endspray penetration
• Thin endspray
• Poor end connection
  • Poor solder or weld
• Not cleared properly
• Assembled incorrectly
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Inferior Materials

- Inferior base film
  - Degree of crystallinity
  - Defects per unit area
  - Substitute quality source for low cost without proving design or control of supply.
- Inferior metallization
  - Poor adhesion
  - Defects in metallized layer
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Typical Process for Analyzing Failure Modes in HVFCs

1. Obtain data on failed caps
2. Samples returned for analysis
3. Visual, electrical and non-destructive tests
4. Teardown
5. Identify failure mode
6. Identify root cause
7. Report
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What are the visual indications and causes of specific failure modes in HVFCs?
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First: This is what a good metallized polypropylene cap winding looks like.
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Corona

- Typical visual indications
  - Loss of metallization (pitting) at metal edge boundaries where field strength is highest and where air gaps may exist.
- Typical causes
  - Vac applied exceeds rated.
  - Loose winding, air gaps
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Excessive clearing

- Typical visual indications
  - Loss of metal in cleared areas where dielectric has been compromised.

- Typical causes
  - Vdc or Vac applied exceeds rating
  - Application temperature exceeds rated temperature
  - End of life (dielectric aging)
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Moisture

• Typical visual indications
  • Large areas of metal corrosion, discoloration without dielectric failure.

• Typical causes
  • Excessive humidity
Peak Current Failure

- Typical visual indications
  - Metallization at end connection deteriorates due to pulsed current
- Typical causes
  - \( \frac{dV}{dt} \) exceeds rating
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Thermal Runaway

• Typical visual indications
  • Massive charring and melting of plastic film

• Typical causes
  • Capacitor voltage or temperature ratings exceeded for extended periods
  • Cascading failure modes
Thank You!
Bio for Scott Franco

- Bachelor of Science Degree in Physics from UMass, 1989.
- Began working at Cornell Dubilier in 1989 as AC and DC Film Capacitor Applications and Design Engineer
- Received MBA in 1997 from Bryant College.
- Transitioned from engineering to product management and sales management roles.
- Currently serves the company as Director of Market Development