Session 4b
Staines II

High-Megawatt Converter Technology Workshop

Capacitor Technology for High-Megawatt Power Conversion

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Film Capacitors for Power Conversion

- **Depending on frequency, capacitors can be the largest component in the system**
- **Requirements are**
  - Low inductance
  - High rms current capability
  - Low loss
  - 100% reversal
  - High energy density
  - GA-ESI paper/polypropylene capacitors developed for SNS

IGBT switch plate assembly
(LANL SNS modulator)

GA-ESI Research Objectives

- Long DC life at high energy density
- High-temperature Polymers
- Novel construction technique for high current and high energy density
- Improved metallized electrodes for self-healing and low ESR
- Packaging for high temperature and thermal management
- Thin film winding for low voltage applications

High Temperature Polymers

- **Polypropylene film capacitors have highest energy density at low temperature**
- **Performance degrades rapidly above 40ºC**
- **Investigating high-temperature films including**
  - Polyphenyl sulfide (PPS)
  - Polyetheretherketone (PEEK)
  - Polyetherketoneketone (PEKK)

Improved Metallization

- Self-healing capacitors use thin metallization deposited on dielectric films instead of foil
- Fault current causes vaporization of metallized layer, quenching the fault discharge
- Thin (~300Å) metallization limits current and thermal dissipation
- Challenge is to improve thermal conductivity without sacrificing self-healing properties
- Self-healing allows operation up to limit of film breakdown voltage for higher energy density

Impact on Converter Costs

- High energy density passive components reduce the need for high frequency switching
- Reduces switching loss and switch stress
- Could use cheaper, more mature switch technology without prohibitive size, weight
- Metallized film capacitors fail gracefully
- Capacitor monitoring could identify when maintenance required to avoid failures

Summary

- **Depending on frequency, capacitors can be the largest components in power converters**
- **Future development to focus on**
  - Increasing energy density
  - Reducing loss
  - Improving thermal management
- **Significant improvements in fast capacitor technology expected from improved engineering using proven film technology**
- **Smaller passive components may reduce requirement for high switching speeds**