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Background

- Increasing use of electricity to fulfill functions on aircraft is an irreversible trend in the future.
- NASA has initiated a research on ultra-light, highly efficient cryogenically-cooled MW-class power electronics converter for future N+3 generation aircraft propulsion applications.
- Understanding of inverter subcomponents' performance at cryogenic temperature is critical
 - Capacitor
 - Magnetics
 - Resistor

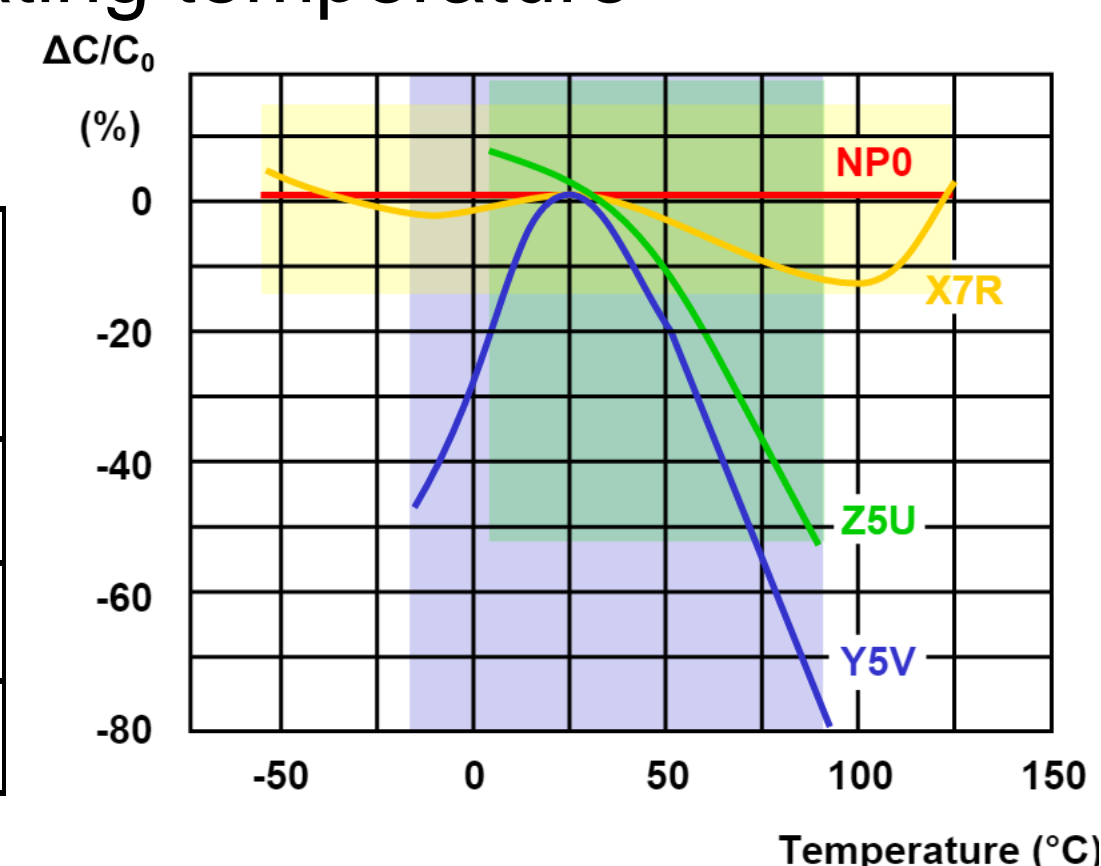


CAPACITOR PERFORMANCE AT CRYOGENIC TEMPERATURE

- Low temperature operation of capacitors depend on the dielectric medium
- For film capacitor, polypropylene capacitor shows promising characteristics at cryogenic temperature
- For ceramic capacitor, NPO shows the best performance under wide operating temperature

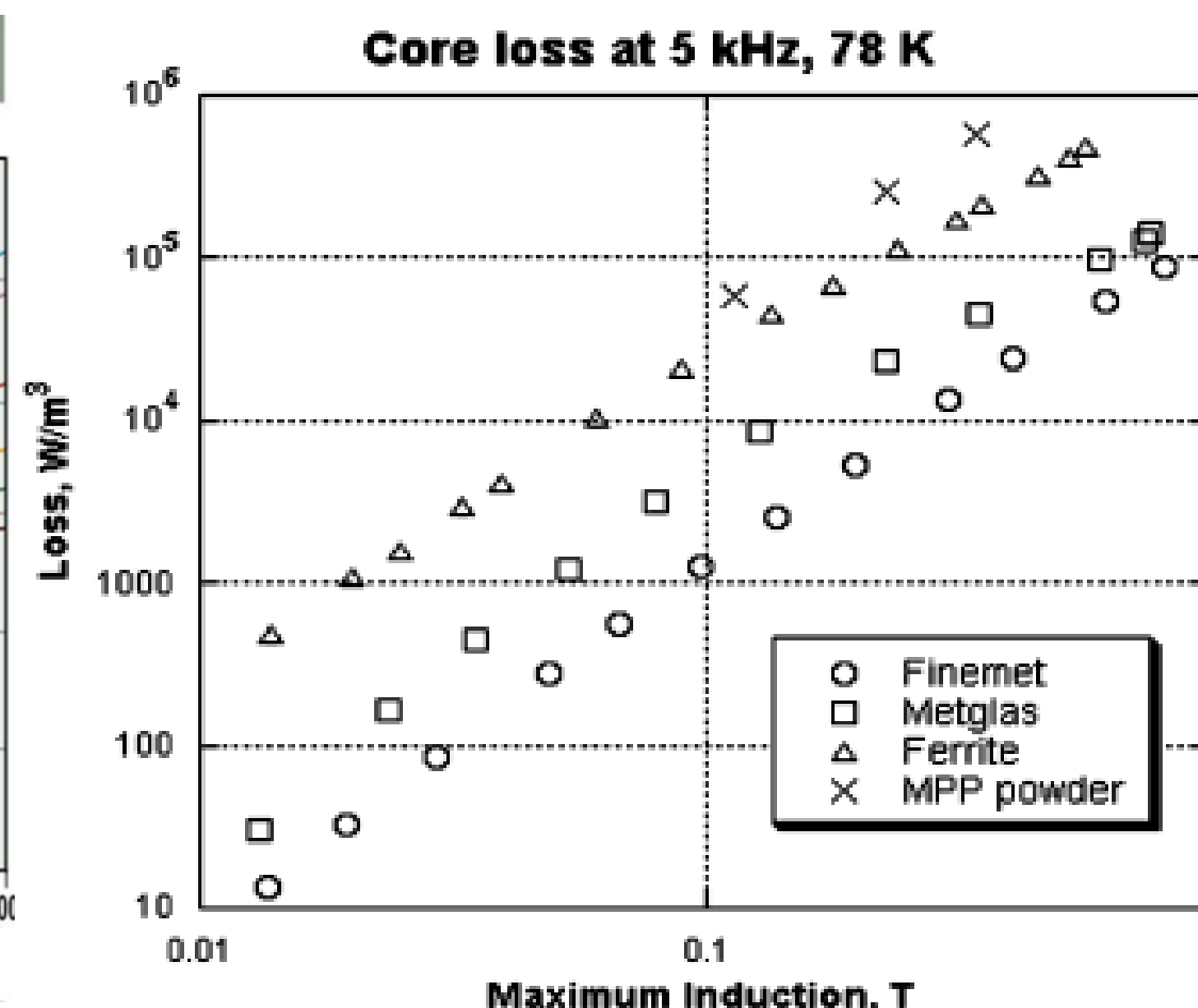
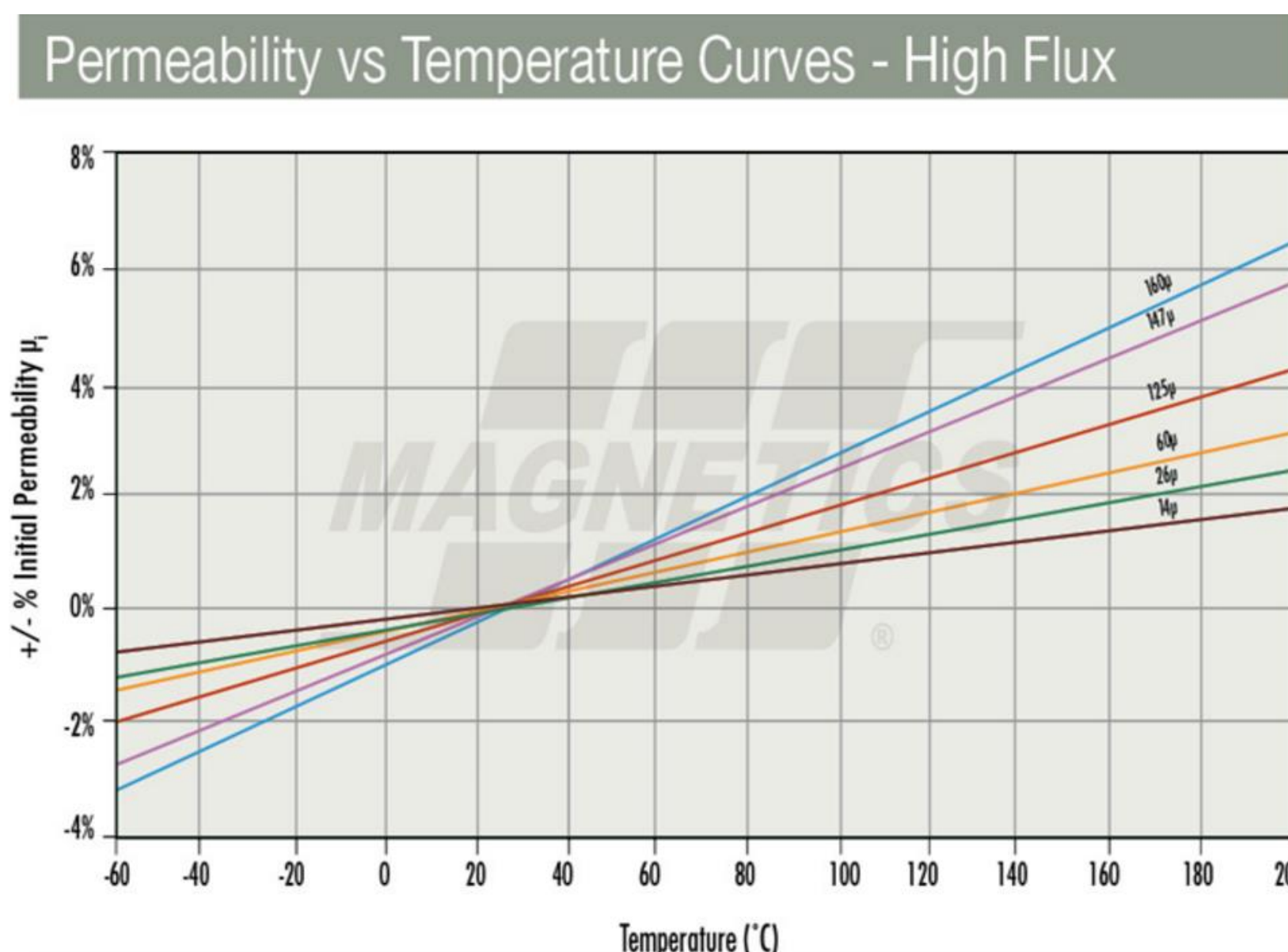
Metallized Polypropylene Temperature and Frequency Characteristics

Capacitance	Rated Voltage	Frequency (kHz)	Capacitance at 293K	Capacitance at 77K	Tan δ at 293K	Tan δ at 77K
10 nF	400 V	1	9.83 nF	10.086 nF	0.001 nF	0.0002 nF
		10	9.83 nF	10.073 nF	0.003 nF	0.0004 nF
		100	9.83 nF	10.104 nF	0.0019 nF	0.0015 nF



MAGNETICS PERFORMANCE AT CRYOGENIC TEMPERATURE

- High Flux
- Experiences low losses
- Stores a great deal of energy
- Nanocrystalline
- Loss will increase by a factor of 2 to 3 at cryogenic temps
- Improvement on amorphous cores
- Very low core loss



RESISTOR PERFORMANCE AT CRYOGENIC TEMPERATURE

- A stable temperature coefficient is desired for resistors
- Metal film resistors have shown to be more reliable than carbon and ceramic capacitors for they have a more stable temperature coefficient

CONCLUSION

- In summary, the most promising for each category is:
 - Film capacitor: polypropylene
 - Ceramic capacitor: NPO
 - Resistor: Metal film

Table III. Percent change in resistance at -190 °C versus resistor type.

