Improved High Speed, Low Loss Materials for Pb-Free Assembly Compatibility

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October 2005

Overview

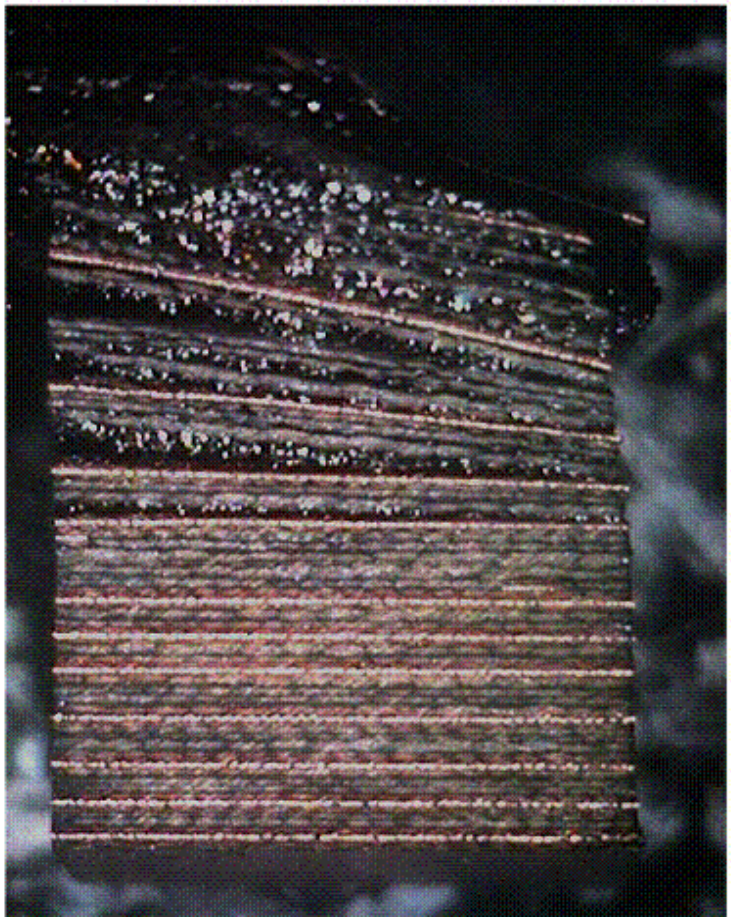
- Environmental Regulations
  - Waste from Electrical and Electronic Equipment (WEEE)
  - Reduction of Hazardous Substances (RoHS)
    - Pb, Cd, Hg, Cr^{VI}
    - Halogenated Compounds
      - Polybrominated biphenyl (PBB)
      - Polybrominated diphenyl ether (PBDE)
      - Tetrabromobisphenol-A (TBBPA) NOT restricted
- Several products exempt until 2010, but component availability concerns are forcing earlier adoption.
  - For example, server manufacturers among the most proactive even though they are exempt until 2010.

Pb-Free Issue For Base Materials

- Differences in peak assembly temperatures:
  - Sn/Pb MP of 183ºC, peak temperatures of 230-235ºC
  - Sn/Ag/Cu MP around 217ºC, peak temperatures up to 260ºC
- Coupled with increasing PCB/PCA complexity:
  - Additional assembly cycles
  - Additional rework cycles
- Can result in:
  - PTH barrel cracking or compromised long-term reliability.
  - Blistering, delamination, or resin degradation.
- Two key issues:
  - Surviving assembly without defects
  - Insuring reliability after assembly

What's The Worst That Could Happen?

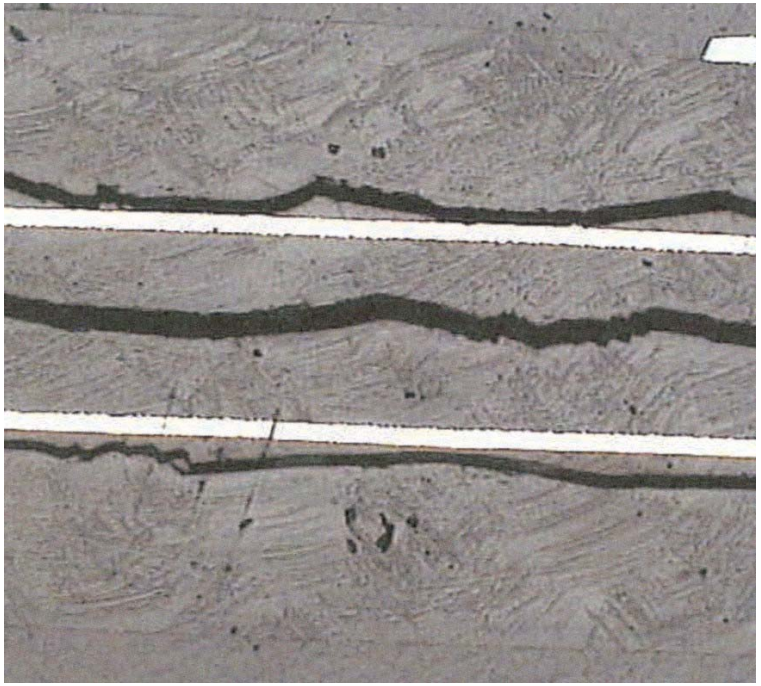
40 Layer FR4 PWB
TMA T-260 Sample

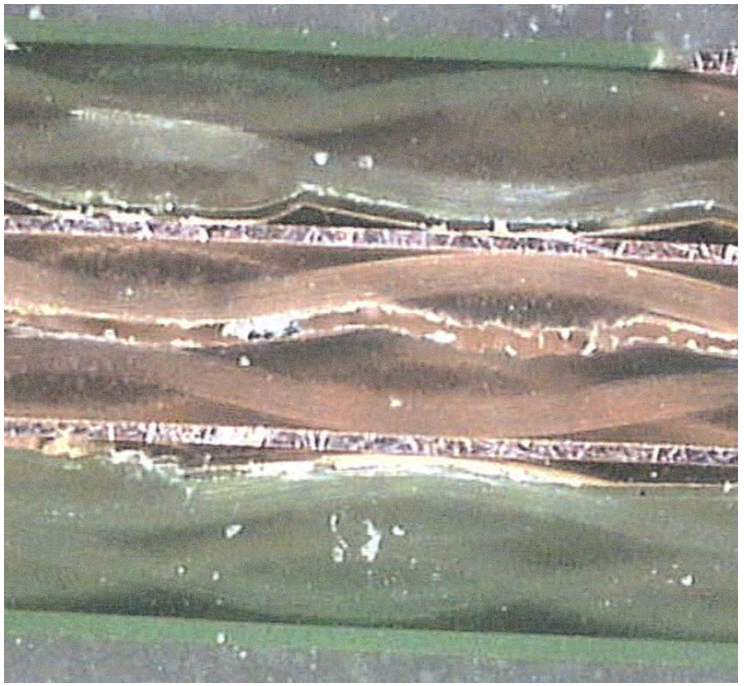


- Example of an 8.4mm (0.330"), 40-layer backplane after T260 testing.
- T260 value was approximately 2 minutes.

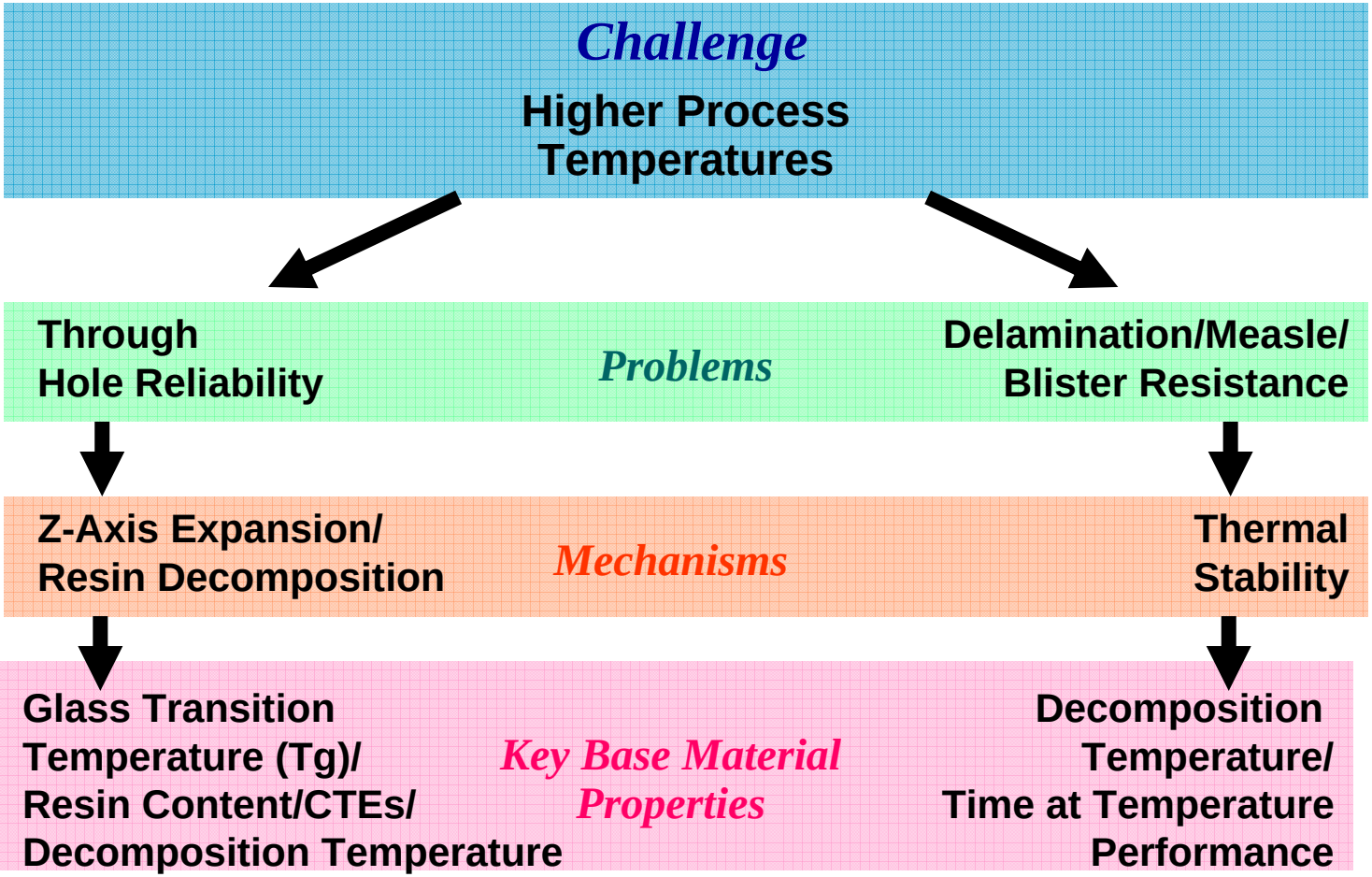
What's The Worst That Could Happen?

- This manufacturer switched to a 175°C T_g FR-4 to "avoid problems" with Pb-free assembly.





Thermal Robustness



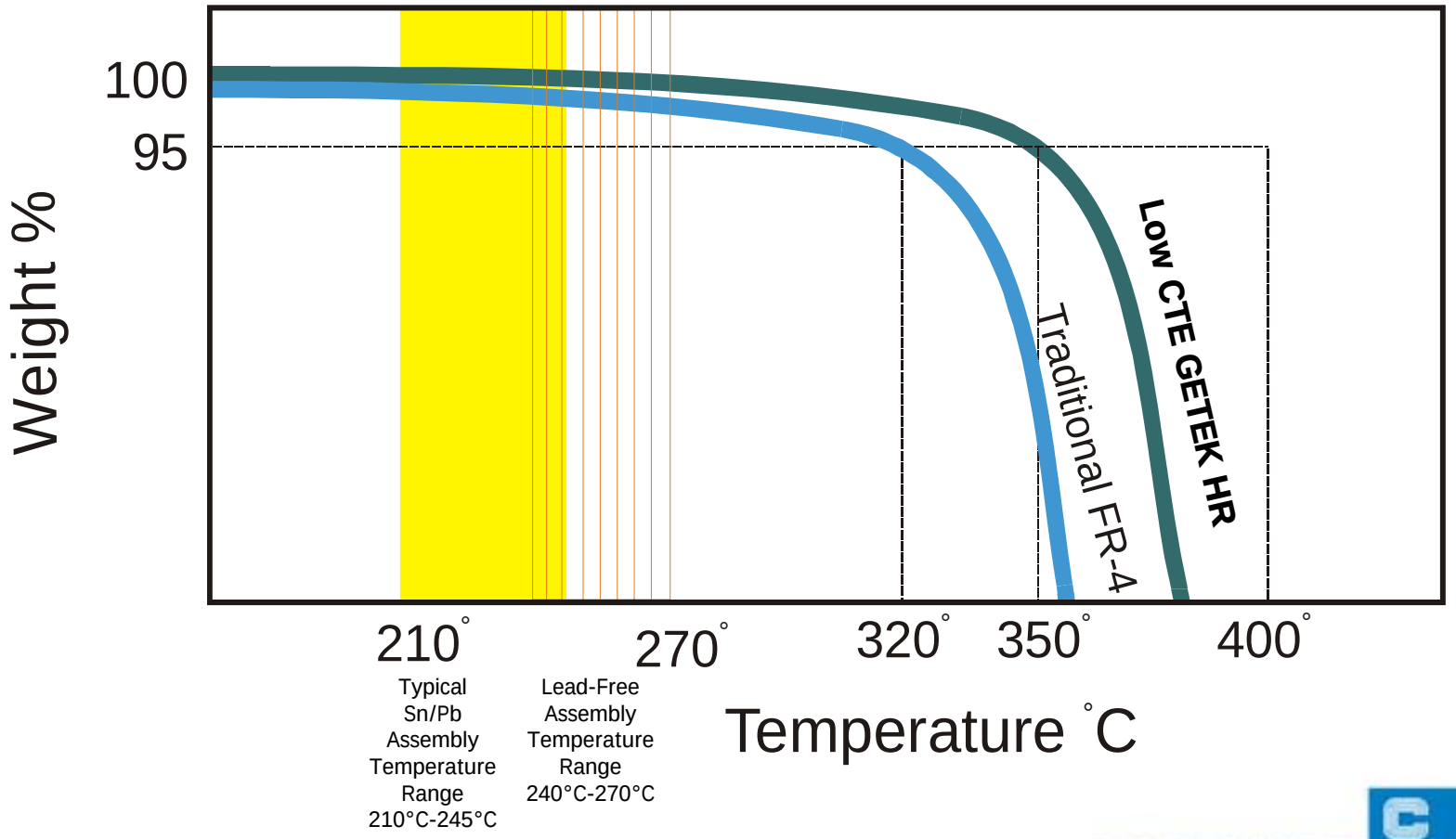
Enhanced Low Dk/Df Product For Lead Free Assembly

Material Performance Criteria:

- Significantly Reduced Z-Axis Thermal Expansion
- Maintain PPO-Epoxy (GETEK®) Electrical Performance
- High Decomposition Temperature
- Exceed 2 Minute Minimum T260 and Survive T288 test requirements
- Exceed IST & Thermal Cycling Requirements
- Superior CAF performance

Enhanced Low Dk/Df Product

Thermogravimetric Analysis



"Enhanced Low Dk/Df Product" Reduced CTE PPO-Epoxy

(GETEK ® HR)

- Description
  - Low CTE PPO/Epoxy
  - Tg 175°C
  - UL-94-V0 flammability
  - PPO-Epoxy Electrical Performance
  - Improved Thermal Stability
  - Reduced % Expansion during Pd Free Assembly

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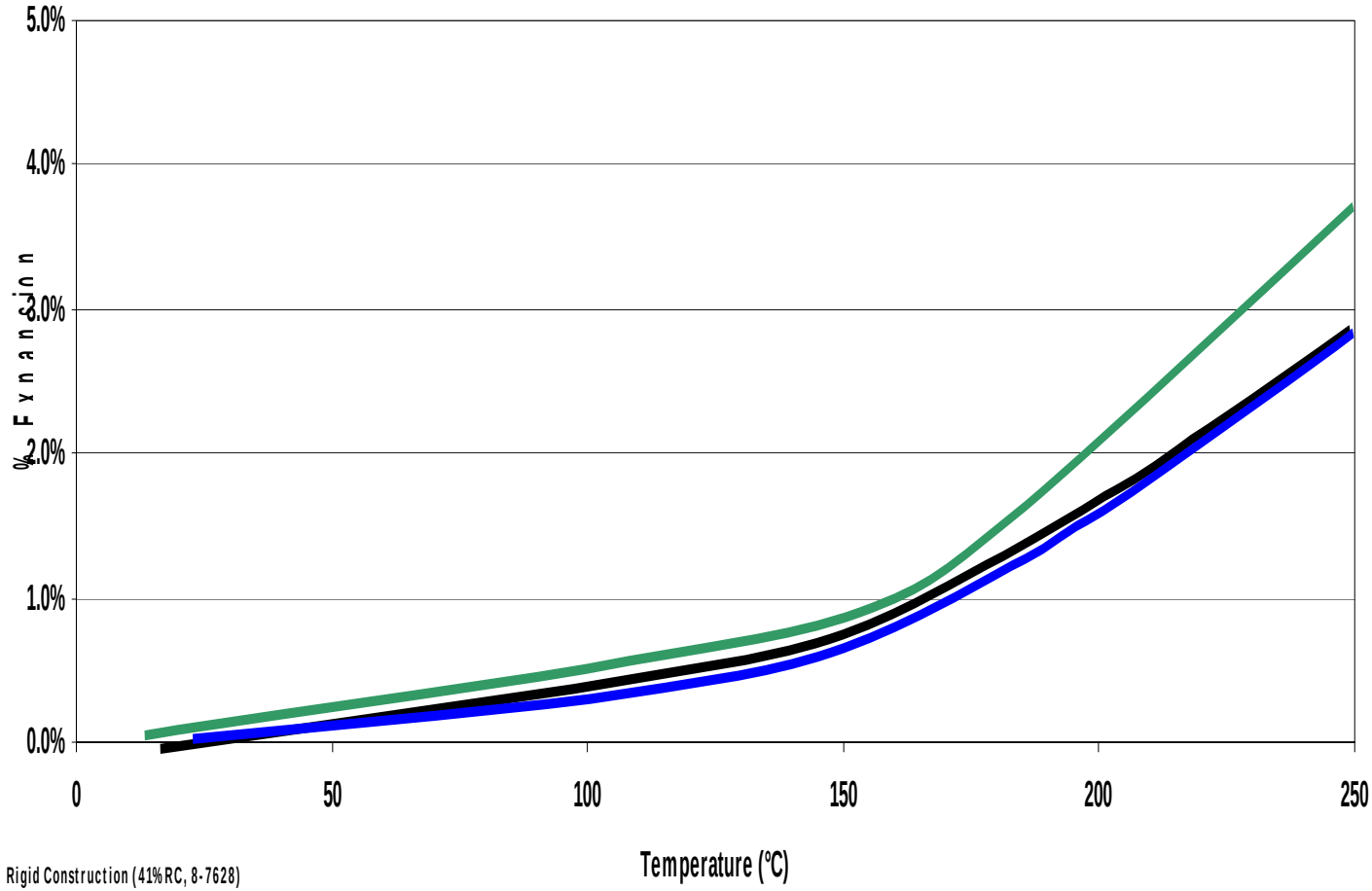
TF1 Do we want to reference TURBO Resin Technology or use some other description... "Advanced Phenolic System"?
Trudy French, 5/30/2003

TF2 Do we need to make reference to the fact the properties between /24 & /98 are the same (difference being the filler)
Trudy French, 5/30/2003

Enhanced Low Dk/Df Product

Thermal Expansion Comparison

8-ply 7628 Laminate



PPO-Epoxy

Low Dk/Df

Low Expansion Lead Free FR-4

Low CTE PPO-Epoxy Low Dk/Df

Material Property Comparisons

Property	Std. 175°C Tg FR4	Pb-Free 180°C Tg FR4	PPO-Epoxy Low Dk/Df	Reduced CTE PPO Epoxy Low Dk/Df	Thermoseting PPO Very Low Dk/Df
DMA Tg, °C	175	180	180	180	210
Pre-Tg CTE, ppm/°C	50	45	55	45	55
Post-Tg CTE, ppm/°C	250	220	255	220	225
% Expansion, 50-260°C	3.5	2.7	3.8	2.7	3.0
Decomposition Temp., °C	310	350	350	350	400
Dk @ 1 GHz	4.4	4.5	3.9	4.0	3.5
Dk @ 5 GHz	4.3	4.4	3.8	3.9	3.45
Df @ 1 GHz	0.016	0.017	0.009	0.009	0.006
Df @ 5 GHz	0.018	0.0185	0.010	0.010	0.007

Enhanced Low Dk/Df Product
Multilayer Test Vehicle

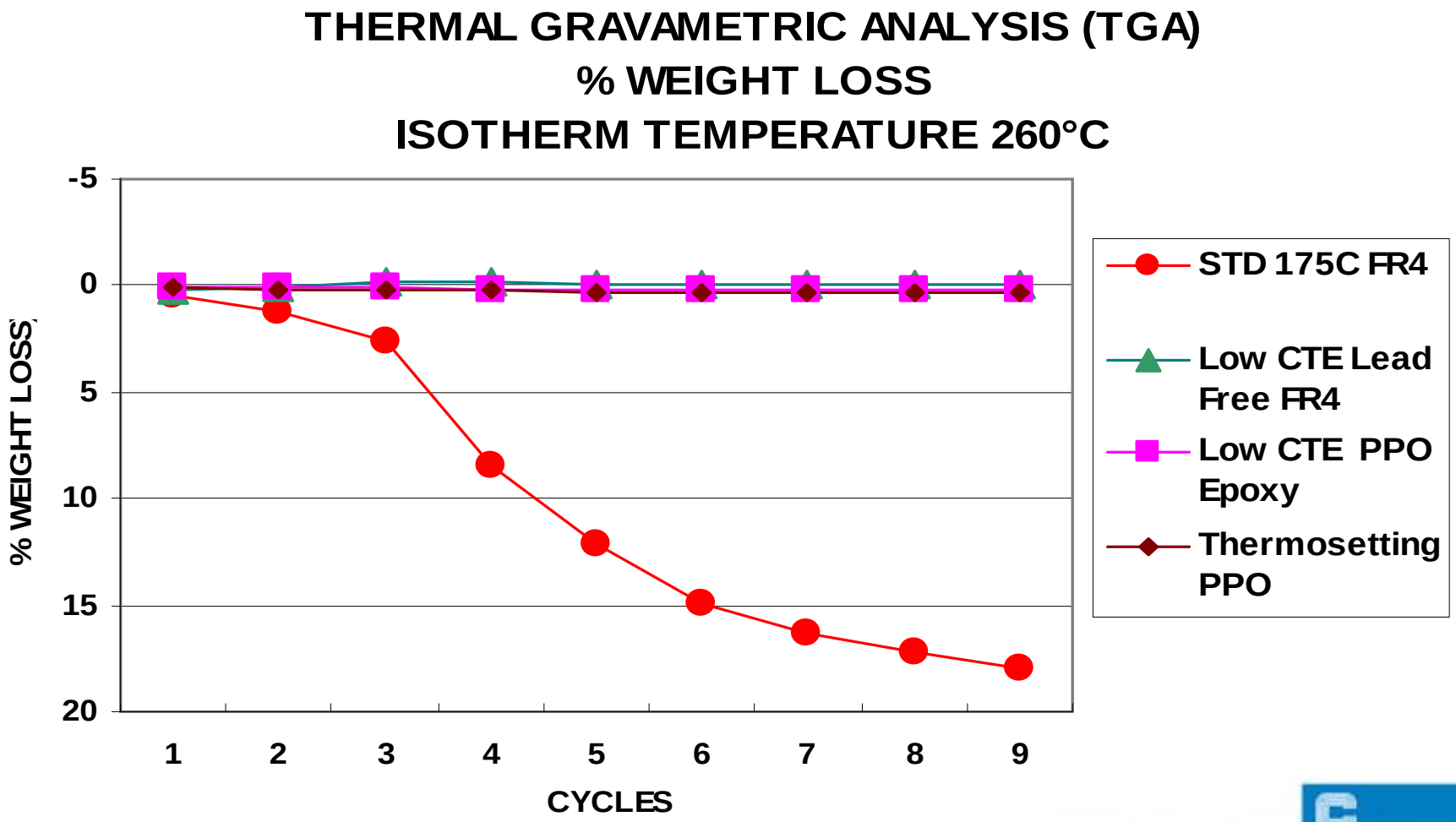
- 10 Layers
- 2.3 mm (0.090”) Overall Thickness
- Property Measurements:
  - Pre-Tg CTE
  - Post-Tg CTE
  - % Expansion, 50 – 260^{o}C
  - T260
  - T288

Enhanced Low Dk/Df Product

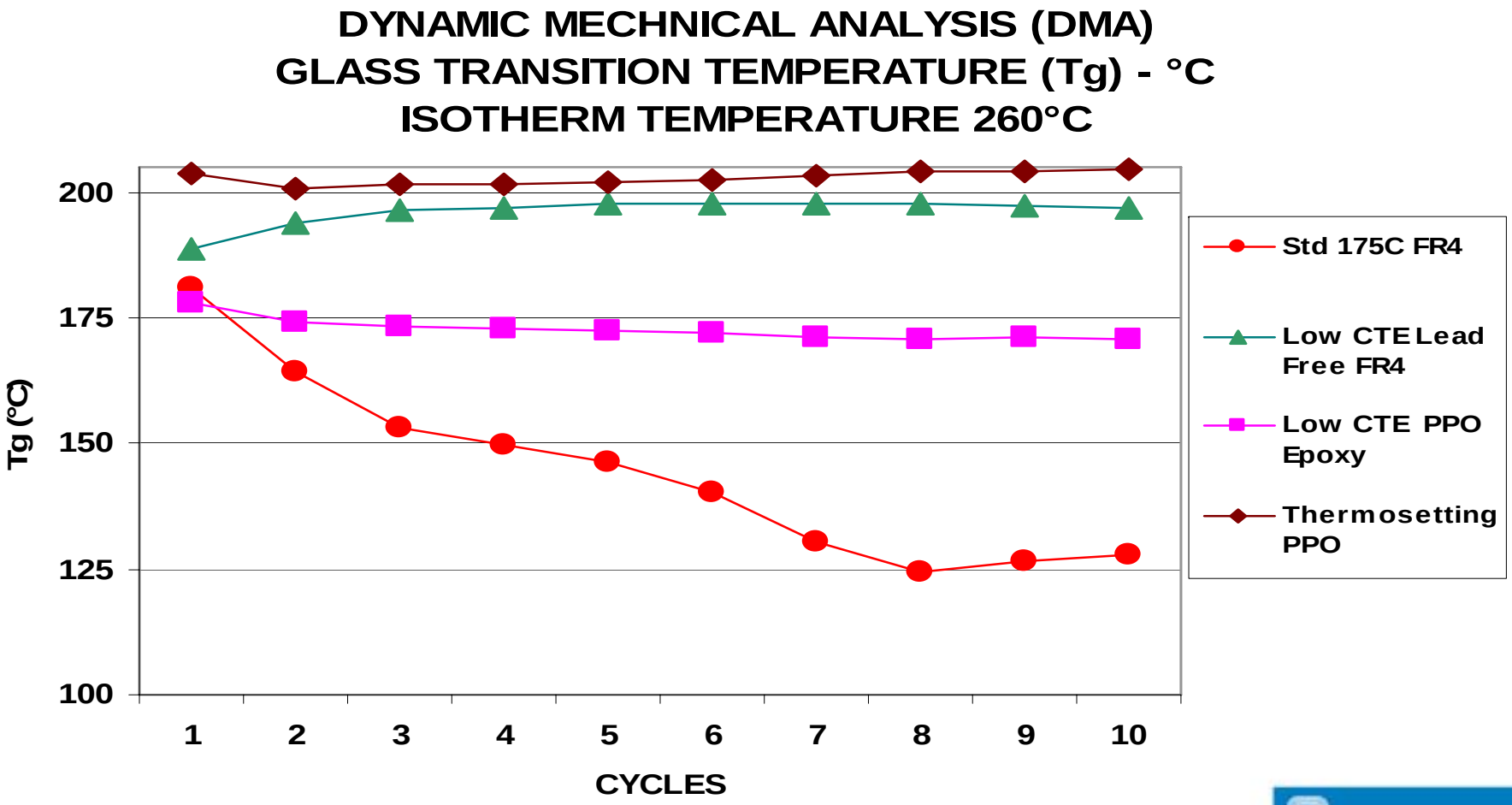
Multilayer Test Vehicle Data

Property	PPO-Epoxy With Copper	Filled PPO-Epoxy With Copper	Thermosetting PPO With Copper
Pre-Tg CTE, ppm/°C	69	53	61
Post-Tg CTE, ppm/°C	335	310	340
% Expansion, 50-260°C	4.3	3.5	3.6
T260, min.	23.8	30+	30+
T288, min.	3.5	4.0	3.0

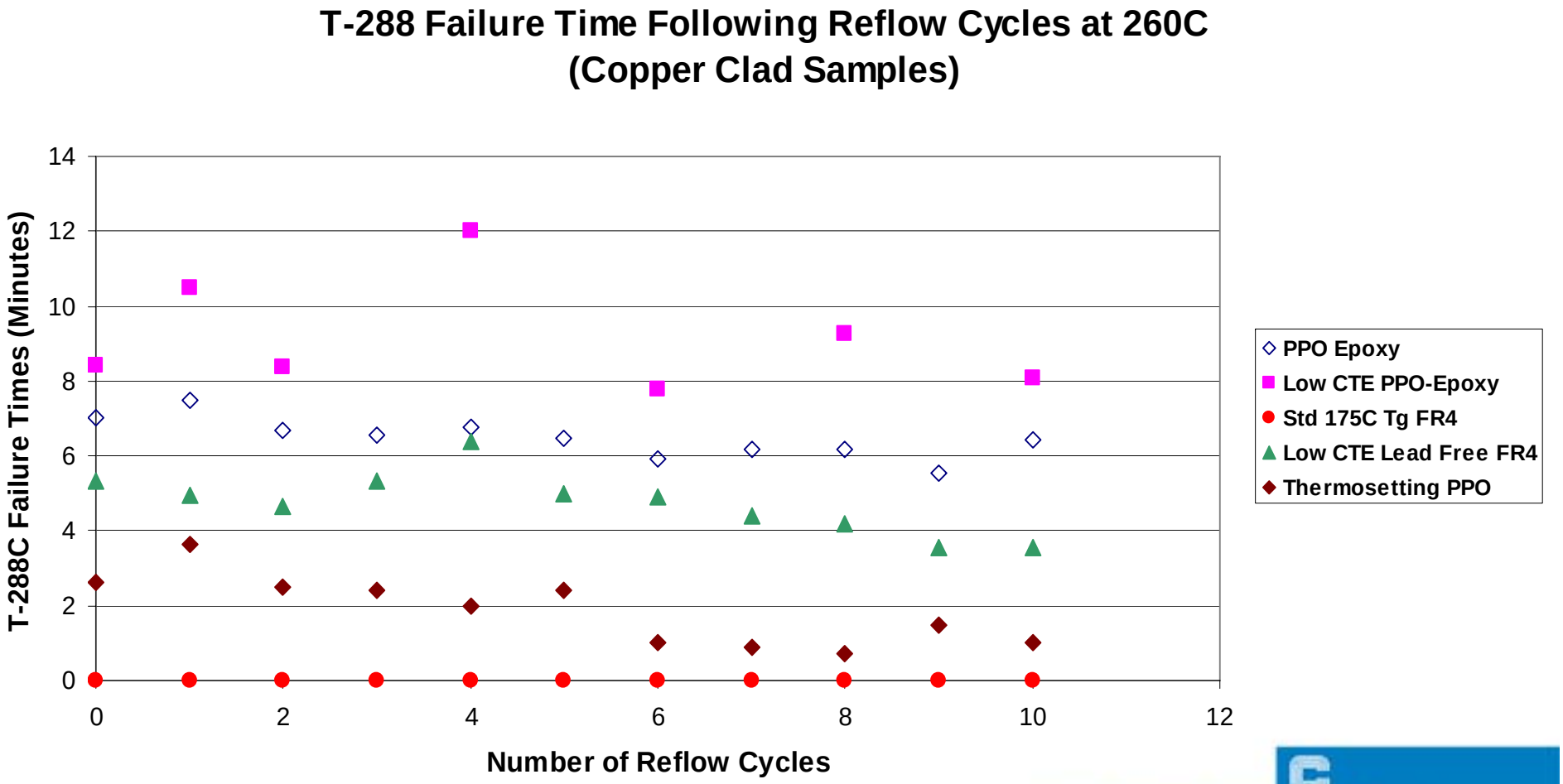
TGA Thermal Analysis
Low CTE PPO Epoxy & Thermosetting PPO



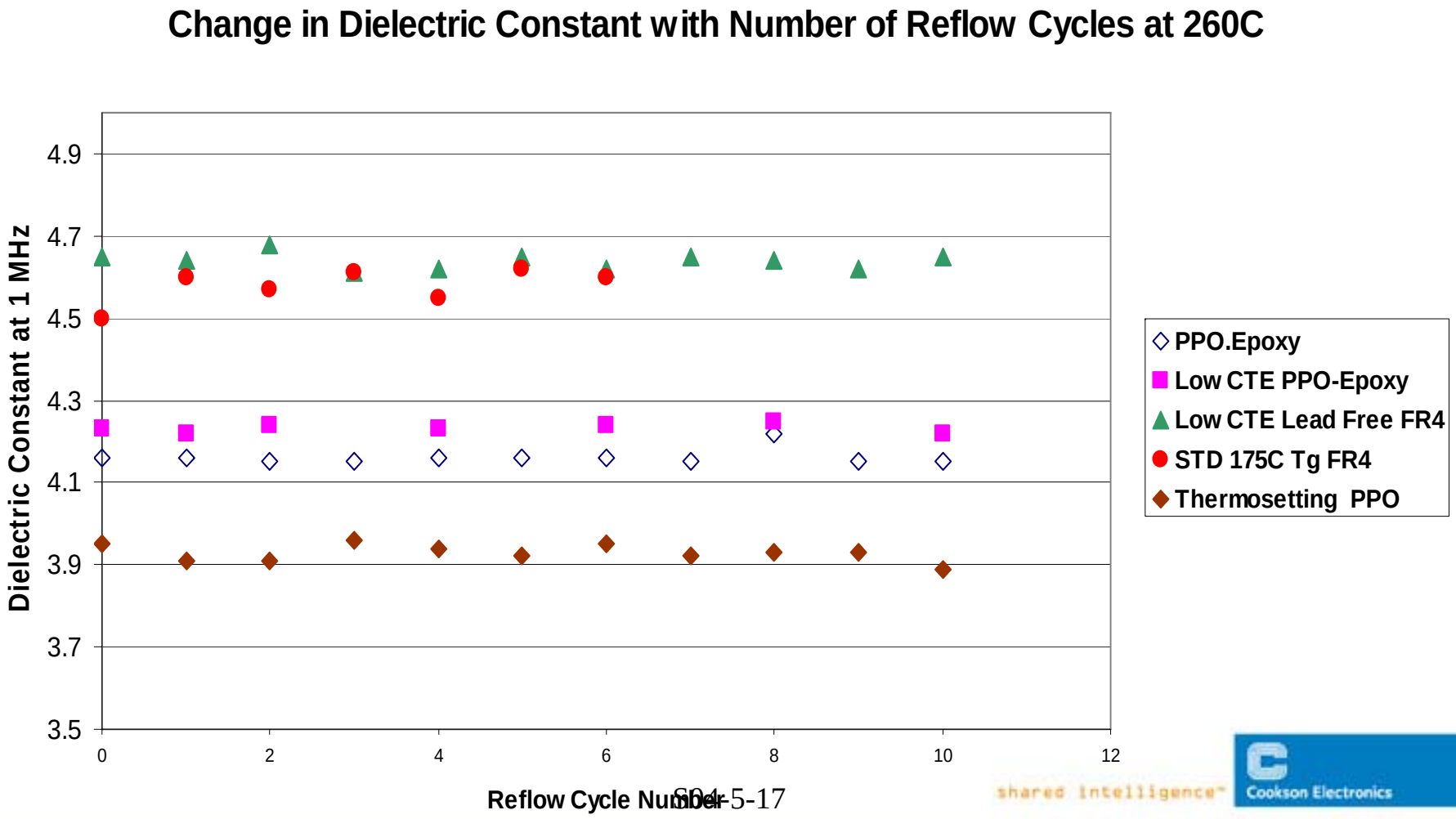
DMA Thermal Analysis-Tg
Low CTE PPO-Epoxy & Thermosetting PPO



T-288 Failure Analysis of Thermally Stable Low DK and Low DF Substrates

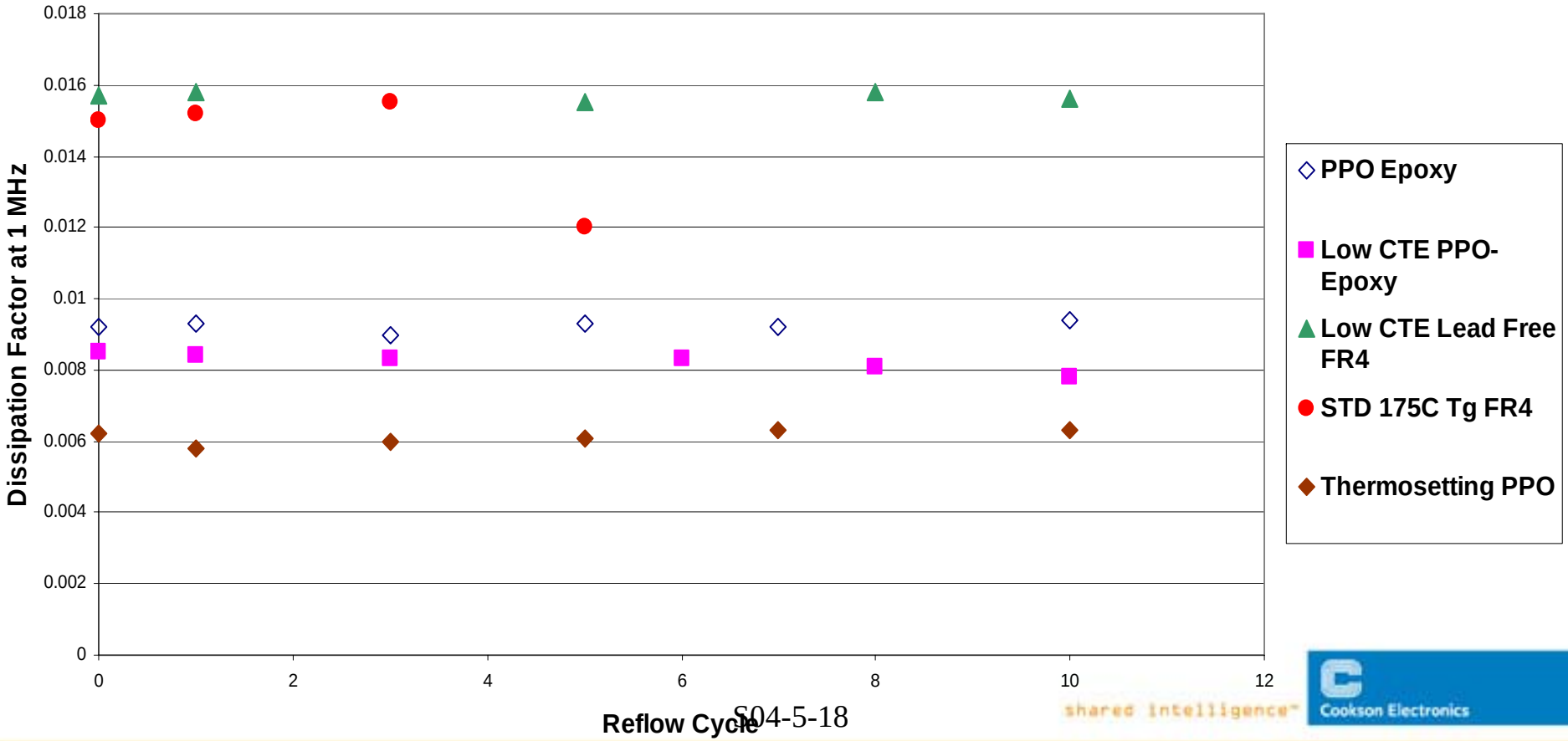


Dielectric Constant Stability of Low DK and Low DF Thermally Stable Substrates



Dissipation Factor Stability of Low DK and Low DF Thermally Stable Substrates

Dissipation Factor vs. Number of Reflow Cycles at 260C



Summary & Conclusions
Enhanced Low Dk/Df Products

- The enhanced low Dk/Df Reduced CTE PPO-Epoxy product exhibits improved properties in comparison to the Lead Free FR4 and PPO-Epoxy Substrates
- Z-axis thermal expansion has been reduced significantly and T-288 times improved
- Thermosetting PPO based substrates have excellent thermal and electrical performance
- Thermally stable FR4, Low CTE PPO-Epoxy, and Thermosetting PPO substrates DK and Df do not change after ten 260C reflow cycles
- Low CTE PPO-Epoxy and Thermosetting PPO based substrates have the high decomposition temperature, and Low % Expansion needed for compatibility with lead-free assembly