How PTFE can compete with the Best in Thermosets

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Introduction

With PTFE's low loss and stable Dk characteristics, its use as RF Microwave printed-circuit board (PCB) substrate is well-established.

The growth in wireless-technology has by extension, driven the RF Microwave industry to design and develop lower-cost PCB substrates for the requirements of an ever- increasingly-competitive market.

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Introduction (continued)

The RF Microwave Laminate industry has responded in recent years by for example using thermosetting plastics along with combined inorganic (ceramic) fillers.

This paper describes a ceramic-filled *PTFE* laminate which was developed to meet the challenge of the commercial RF Microwave industry requirements.

Scope

- This presentation describes the competitive properties of a newly-developed *"low-cost"* PTFE-based copper-clad laminate for use as a base material for RF/microwave printed circuit boards (PCB's).
- It deals specifically with the laminate's performance in key attributes versus ceramic-filled thermoset plastics with a Dk value in the region 3.3 - 3.5.

Continued...

Scope

- The presentation is primarily directed at the “commercial” RF/microwave market where Dk 3.5 materials are being used for double-sided stripline PCB constructions. It will also address the material’s suitability for multilayer designs.
- It will show that not only does the material *compete* with thermoset systems - it many aspects it **outperforms** them!

Definitions

PTFE (polytetrefluoroethylene) is a thermoplastic. Thermoplastics are materials which can be heated and formed, then re-heated and re-formed repeatedly.

Continued...

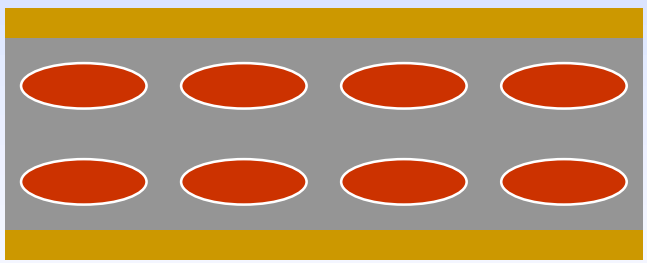
Definitions

Thermoset plastics undergo a chemical as well as a phase change when they are heated. Their molecules form a three-dimensional cross-linked network. Once they are heated and formed they cannot be re-heated and re-formed.

Description of new PTFE laminate

- Ceramic-filled PTFE
- Woven glass reinforced
- Copper-clad

Schematic;



Copper Foil
PTFE/ceramic/glass

PTFE/ceramic/glass
Copper Foil

How does it differ from “traditional” woven PTFE laminates?

- Uses “building-blocks” of 0.010” (0.25mm) woven-glass/ PTFE/ceramic matrix
- Each 0.25mm component uses 1 ply woven-glass type 7628
- “Traditional laminates” can use multiple plies of thinner woven glass along with pure PTFE “skive” materials to match Dk values.

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- Fewer components therefore lower unit cost

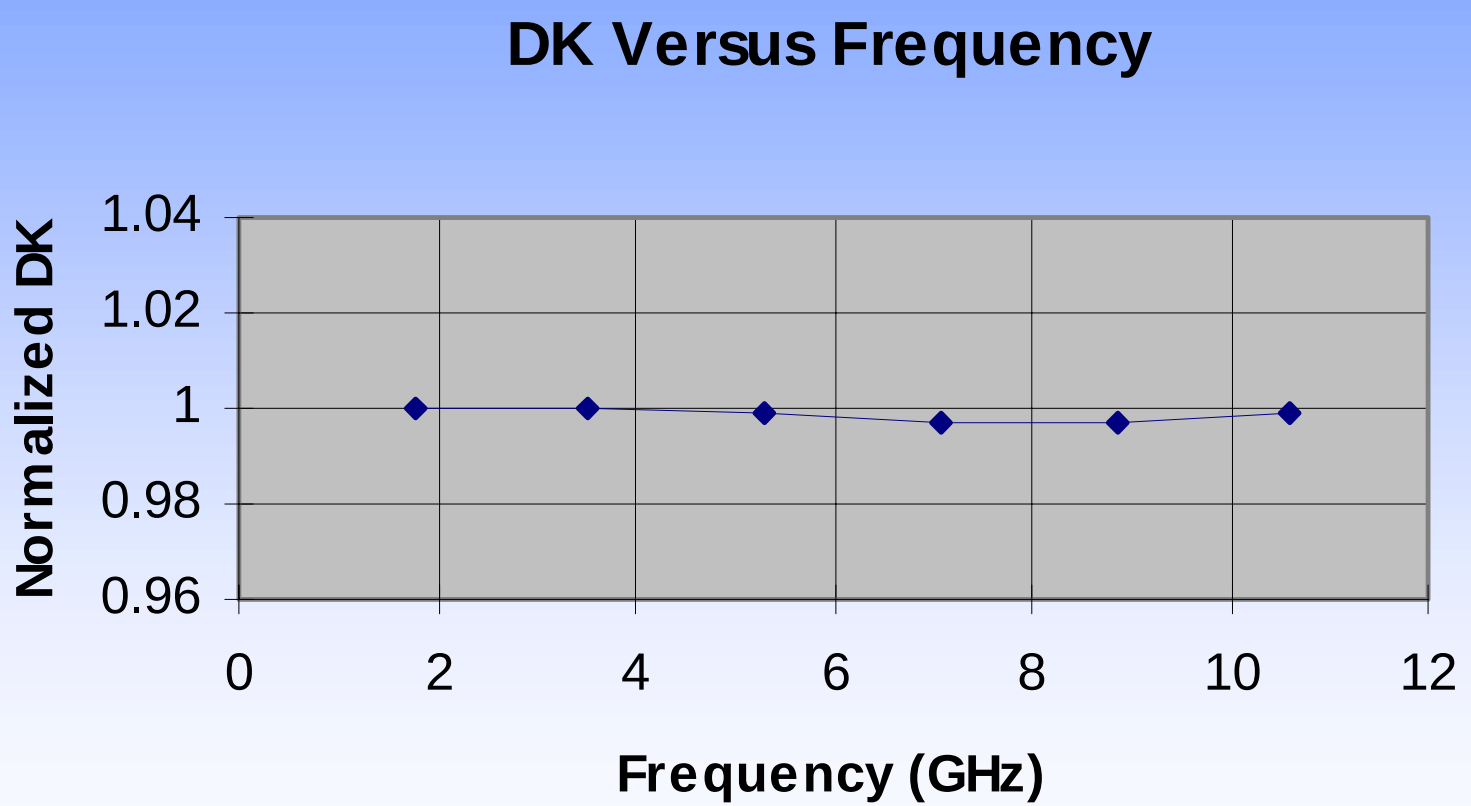
How does it compete?

Performance……..

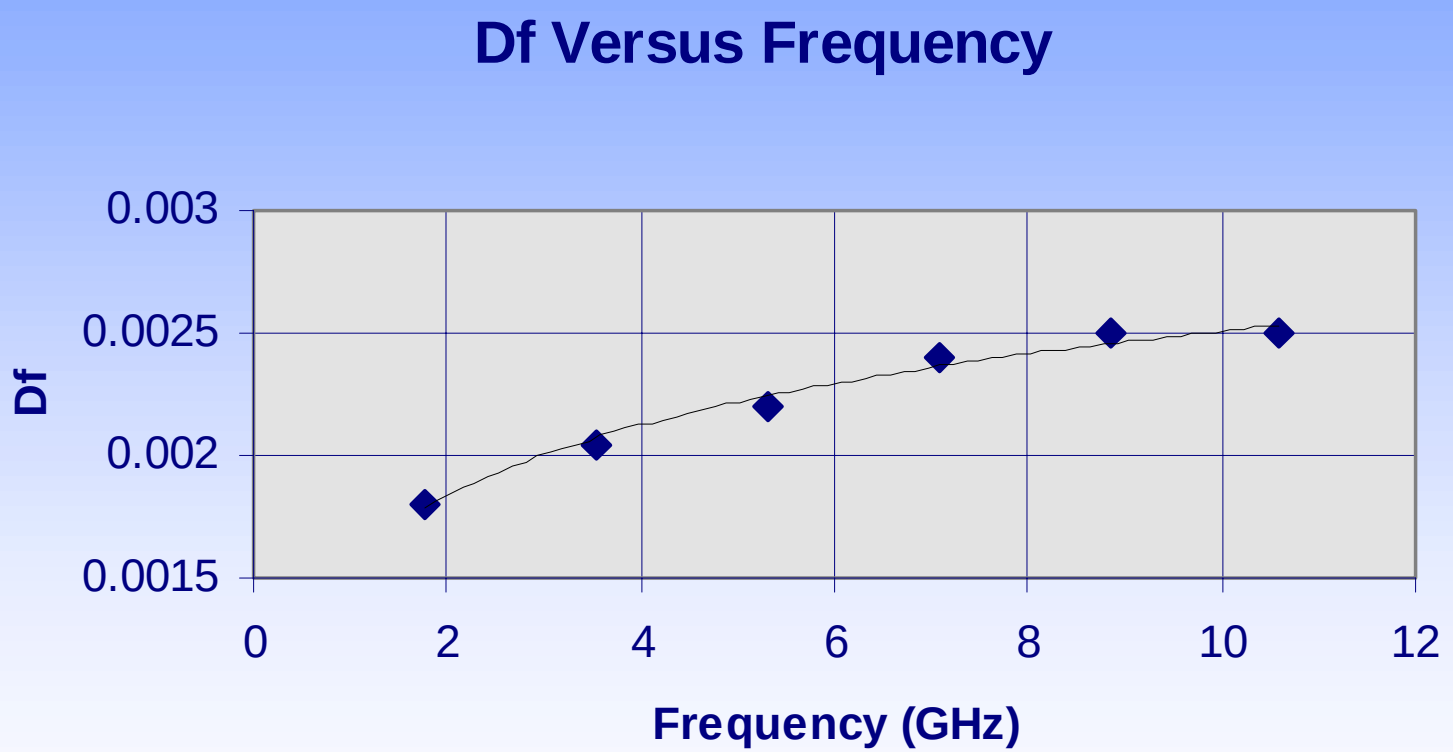
- Stable DK through frequency range
- Comparatively *better* loss e.g. Df of 0.0018 @ 1800 MHz
- Comparatively *better* moisture absorption @ 0.02%
- Comparatively *better* copper peel-strength @>12lb/in (1.8N/m) for 1 oz and 8lb/in (1.5N/m) for ½ oz

Continued…

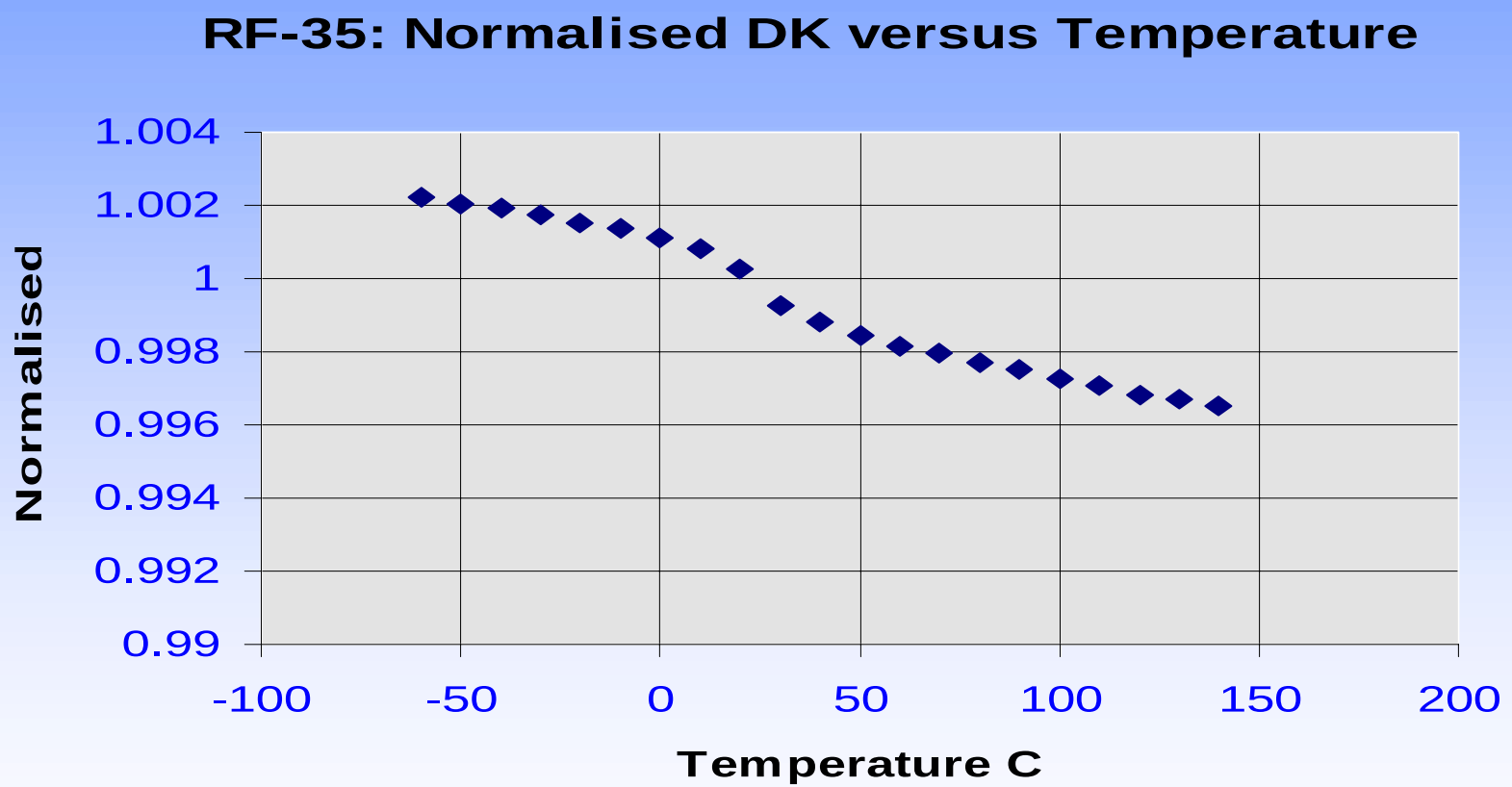
Performance (Continued)



Performance (Continued)



Performance (Continued)



How does it compete?

Performance……..

- Flammability class of UL-94 V-0; Flame-retardants added to thermosets have a detremental effect to performance.
- UL Thermal index value of 105 °C
  (best thermoset value: 55 °C)
- Stable dielectric thickness across entire manufacturing sheet; 1220 mm x 914 mm (48” x 36”); e.g. 0.020” ± 0.0015”

How does it compete?

Cost……..

- Consistently and comparably *lower* price/area laminate price
- Consistently and comparably *lower* finished PCB prices even allowing for additional processing costs viz. sodium etch, plasma etch.

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Costing Comparison

- The lower peel-strengths of thermoset laminates can dictate comparably lower drill stack-heights (to prevent copper “burring”). Can be 50% less than ceramic-filled PTFE.

  Note: drilling is typically the largest process cost associated with PCB manufacture

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Costing Comparison

- Processing costs associated with plasma-etch/sodium-etch treatment of drilled holes in PTFE laminates approximate to $ 0.10 for plasma and $ 0.20 for sodium-etch (per panel costs).

Physical Properties

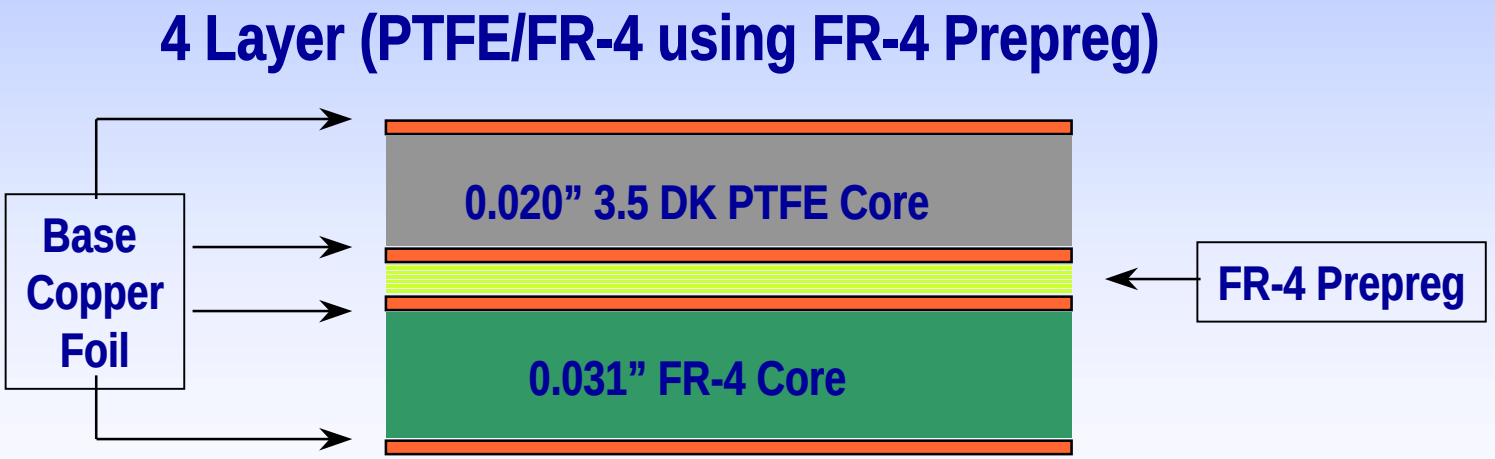
- Peel Strength: $^1/_2$ oz: > 8 lbs/in (>1.5 N/mm)
  1 oz: > 12 lbs/in (>1.8N/mm)
- CTE: X-Y: 19-24 ppm/ ^oC, Z: 64 ppm/ ^oC
- Dimensional Stability: X: 0.00004 in/in,
  Y: -0.00010 in/in
- Flexural Strength: X: > 22000 psi, (>152 N/mm^2)
  Y: > 18000 psi, (>124 N/mm^2)
- Flammability: UL-94 V-0
- Hardness (Rockwell M Scale): 34

Product Offering

- 0.0100” (0.25mm)
- 0.0200” (0.51 mm)
- 0.0300” (0.76 mm)
- 0.0600” (1.52 mm)
- Cladding: 0.5, 1.0, 2.0 oz ED copper

Multilayer Constructions

Example of a four-layer PTFE/FR4 hybrid



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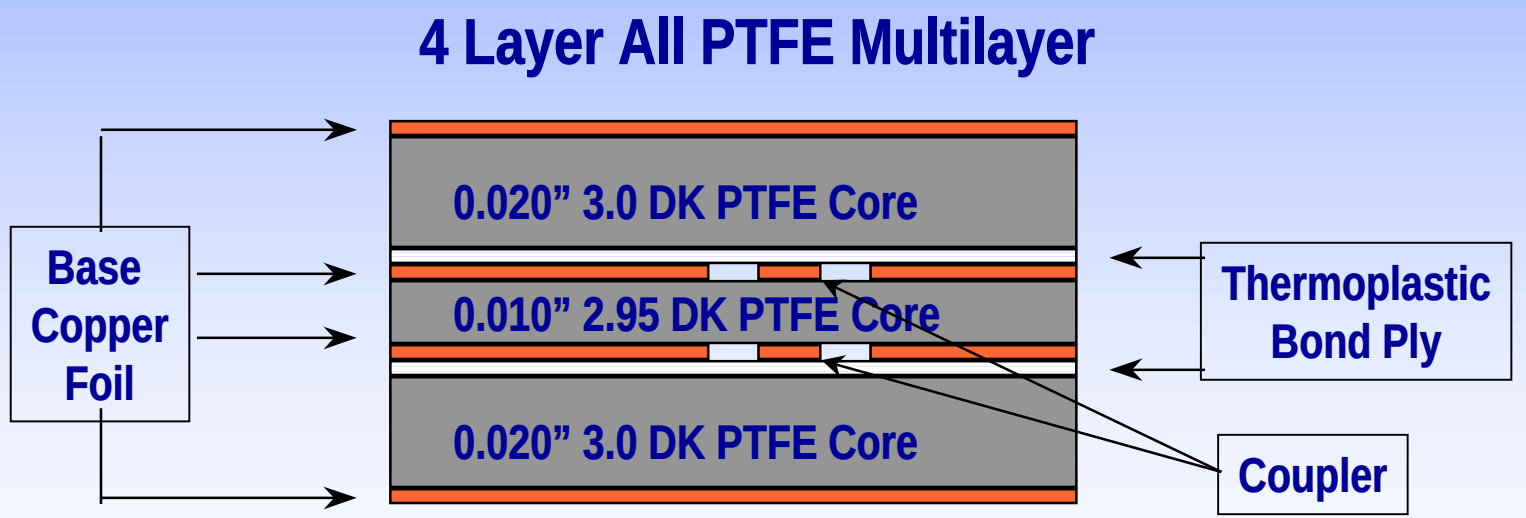
Multilayer Constructions

Example of a four-layer PTFE multilayer



Summary

- Low Cost
- Low Loss Tangent
- Stable Dk Over Frequency
- Consistent Dk Within a Sheet
- High Peel Strength
- Very Low Water Absorption
- 94-UL V-0 Flammability