TacPreg™/IS630

PTFE Based Solutions for the Future of High Speed Digital

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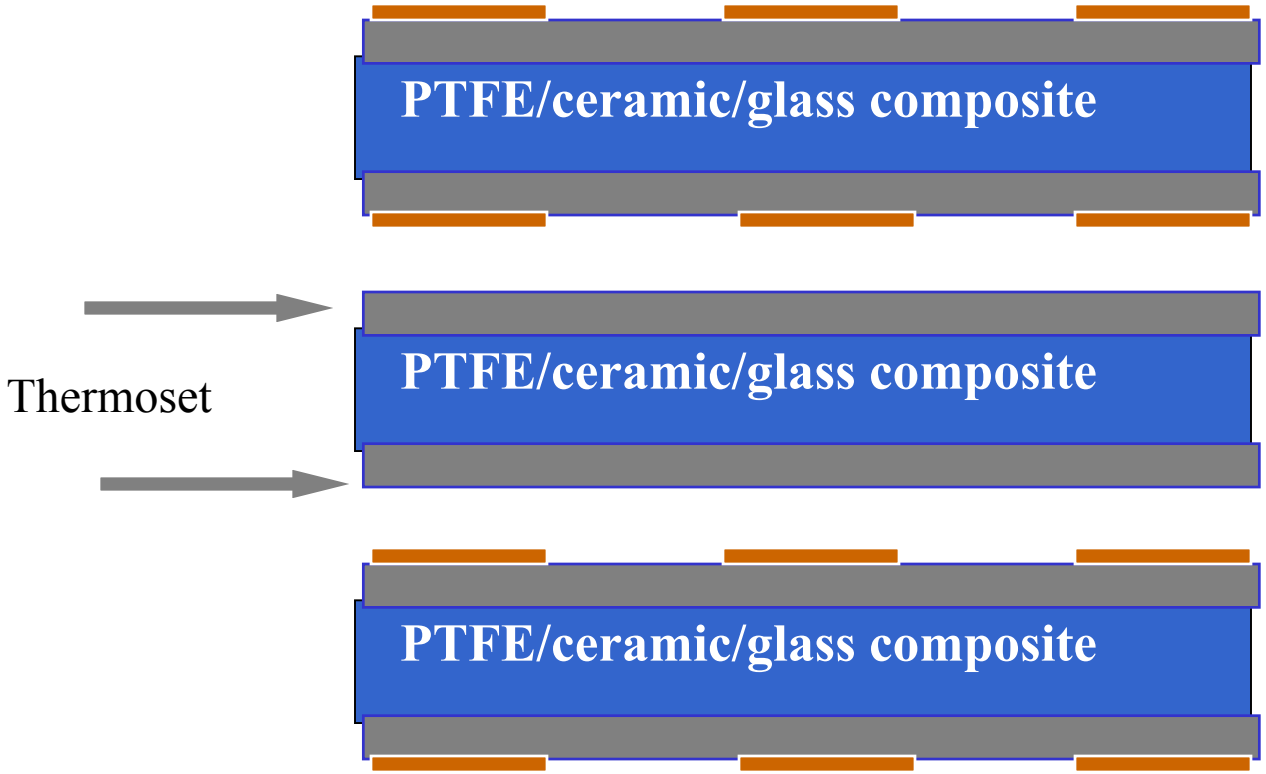
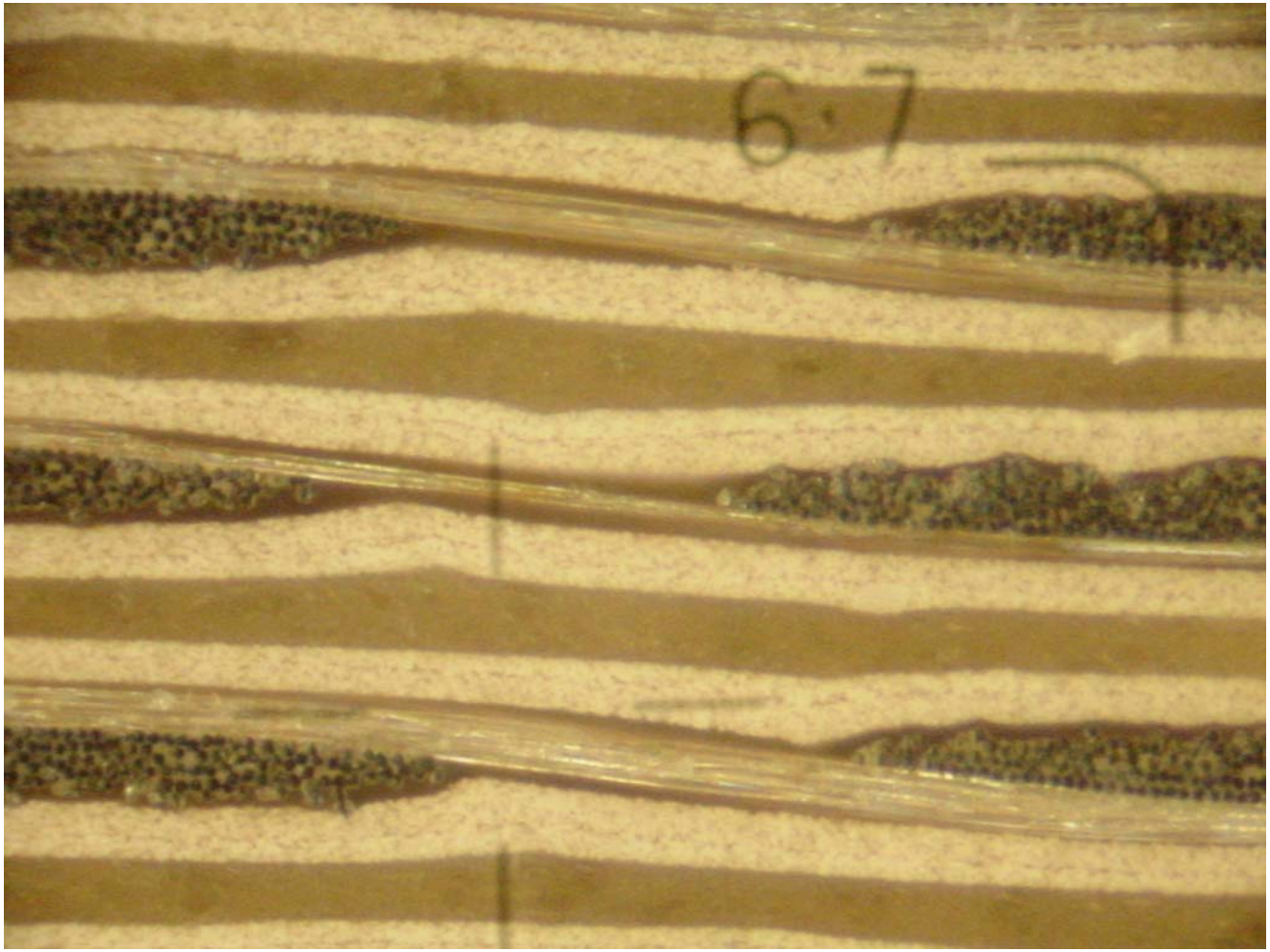
PTFE/fiberglass/thermosetting resin hybrid

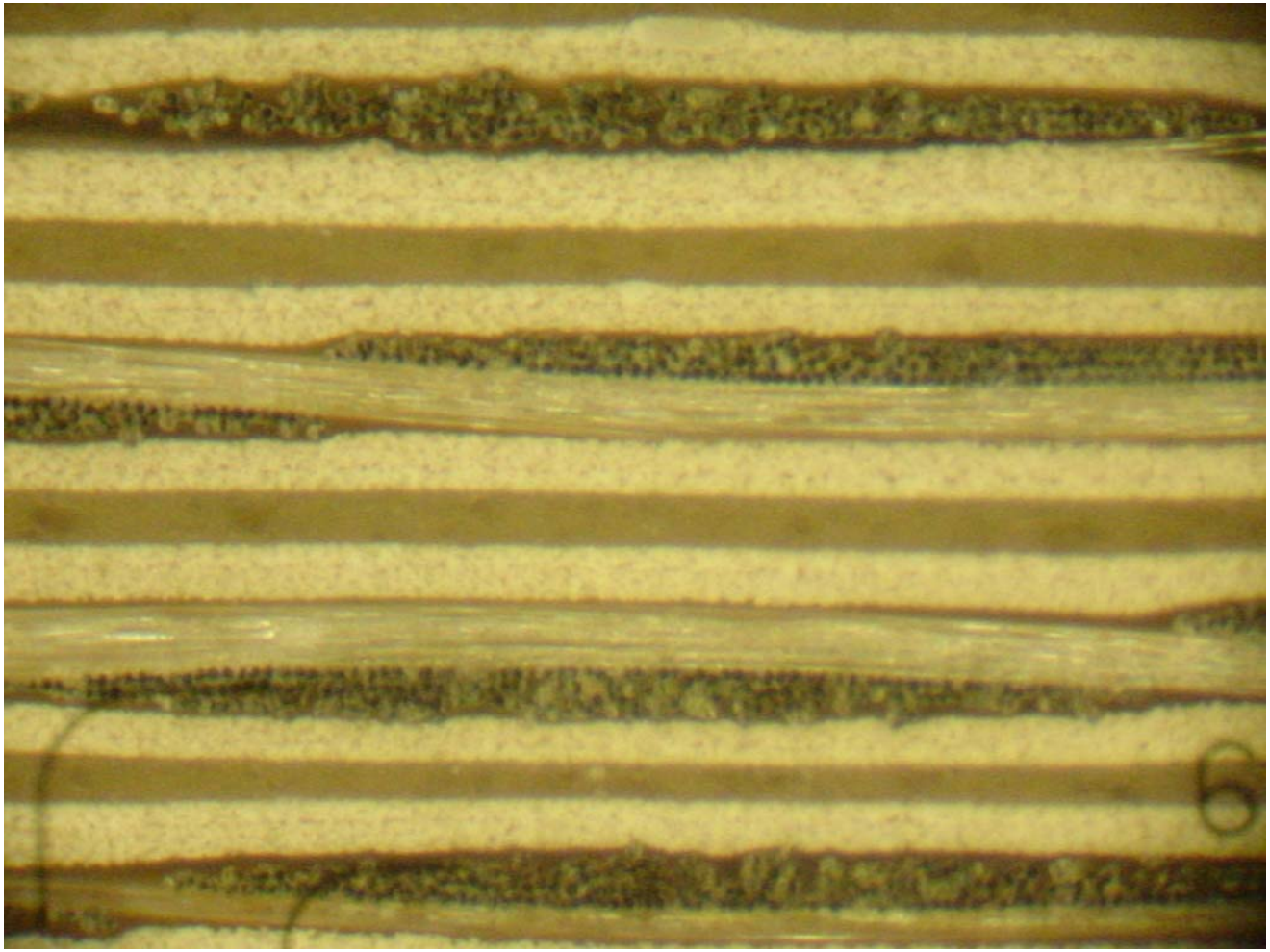
(patent pending)



PTFE/fiberglass/BT-epoxy Laminate (Fill)



PTFE/fiberglass/BT-epoxy Laminate (warp)

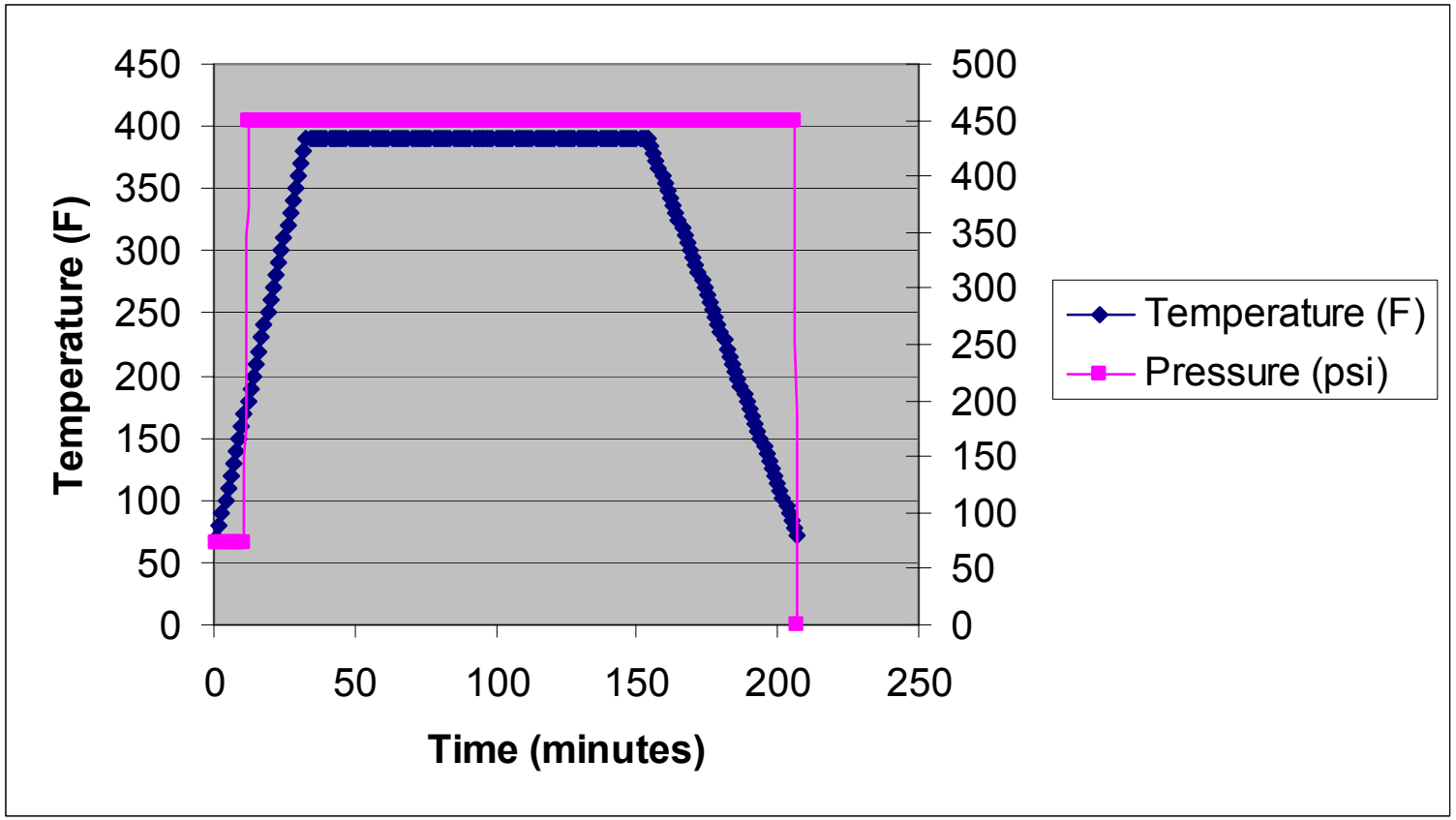


PTFE/Fiberglass/Thermoset Approach

Allows a lot of flexibility to modify system with regard to loss, Dk, CTE, etc.

- PTFE/fiberglass
  - low loss
  - low moisture absorption
  - good dimensional stability
  - predictable movement
  - enables use of very low levels of flame retardant
  - very high thermal stability
  - growing fabricator base
  - low risk
- BT-epoxy
  - used as an adhesive layer only
  - highest loss component fills gaps and excess squeezes out
  - can be minimized for laminate cores
  - improves the drill performance of standard PTFE/fiberglass composites
  - provides robust bonding to copper and innerlayers
  - degree of flow can be readily adjusted

PTFE/fiberglass/BT-epoxy Lamination



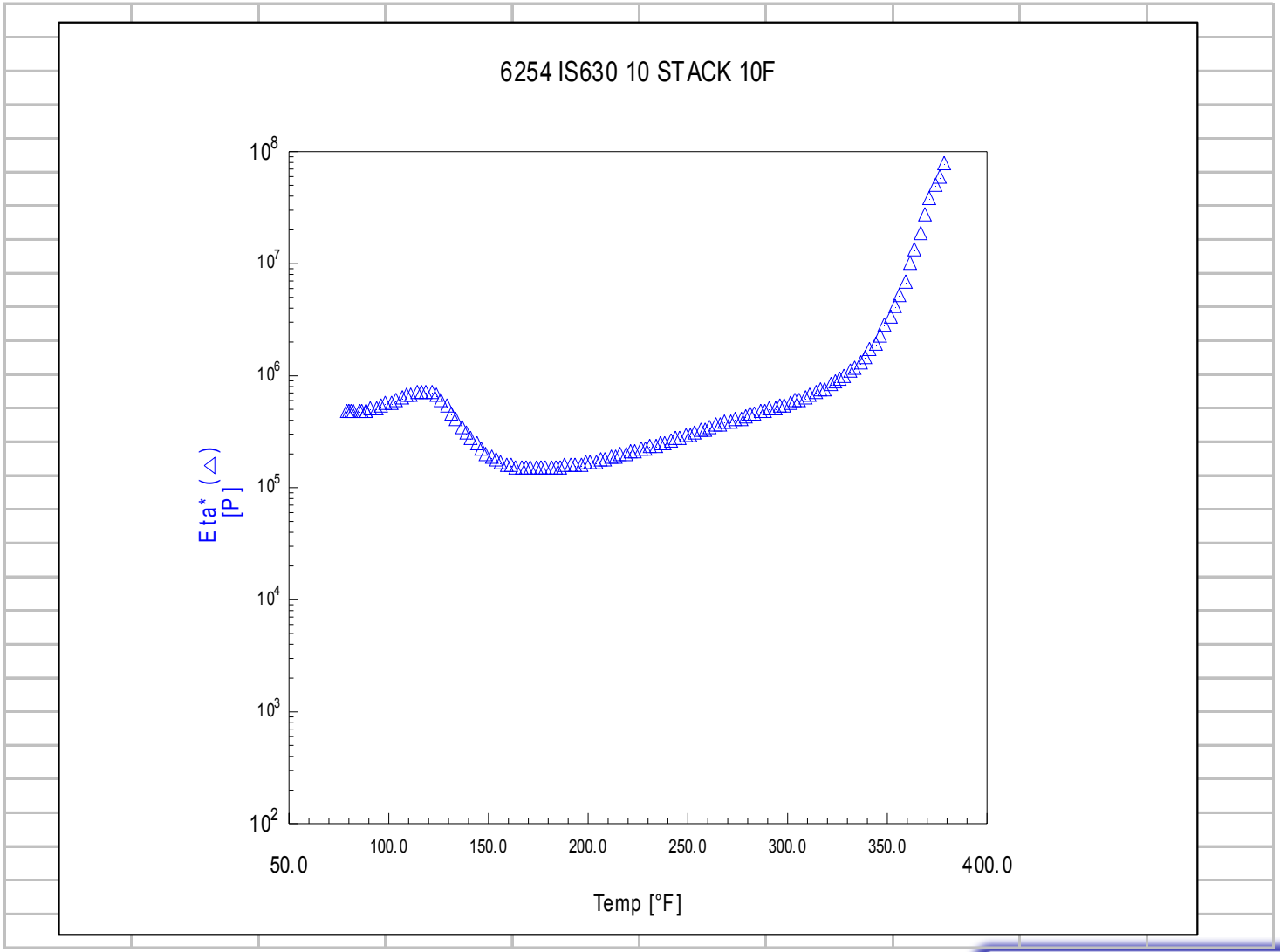
392°F/200°C lamination temp

Lamination Conditions

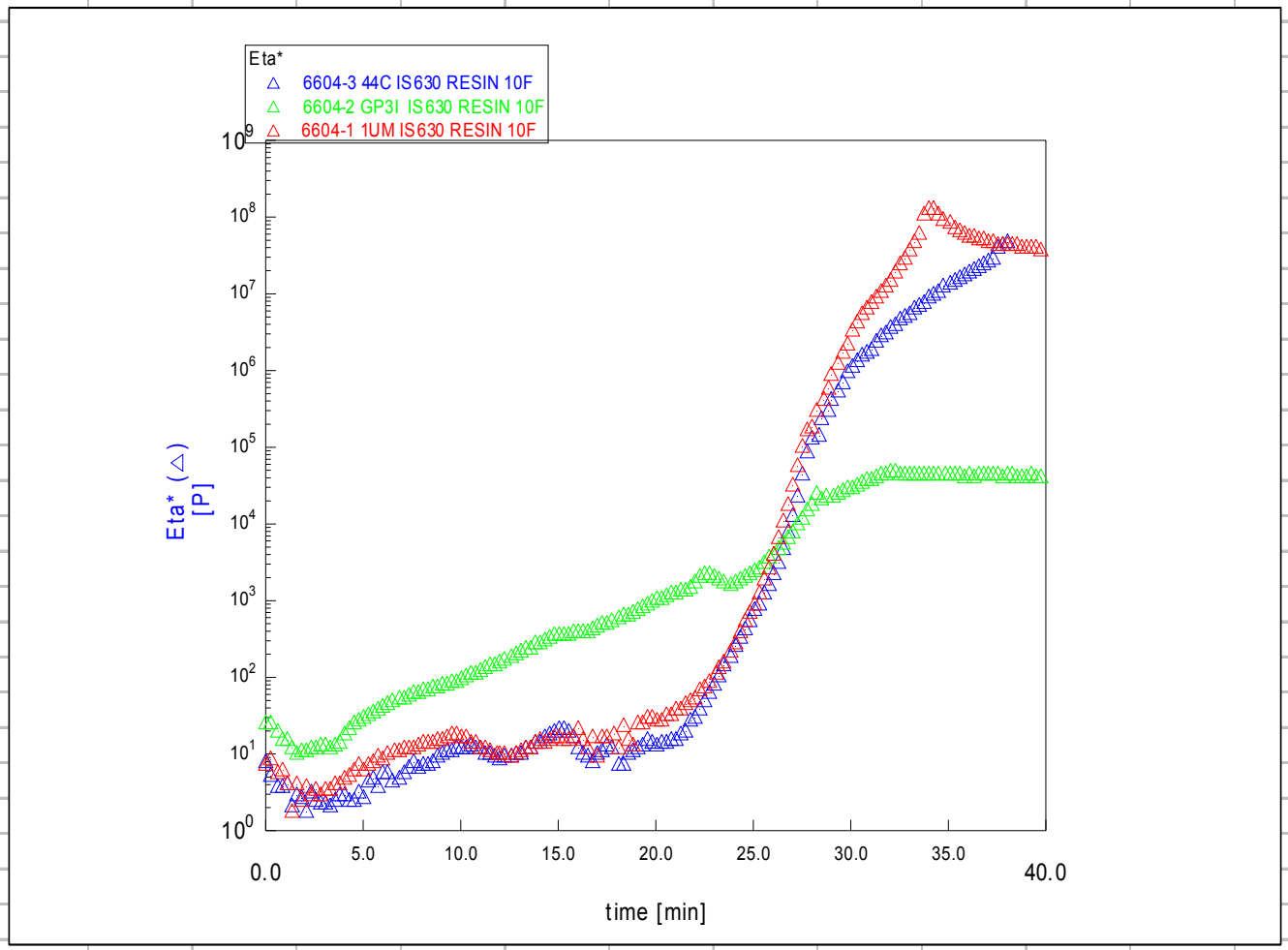
Sample	Wt% BT-epoxy	Heat Rate (°C/min)	Hours (392°F)	Tg/°C (DSC)	Tg/°C (TMA)	Tg/°C (DMA)
1-1	22	8	2	142	155	126/150
1-2	35	8	2	-	152	124/162
2-1	22	8	1.5	142	160	125/148
2-2	35	8	1.5	146	162	123/158
3-1	22	8	1.0	145	156	127/155
3-2	35	8	1.0	143	156	123/158
4-1	22	4.2	2	142	160	126/154
4-2	35	4.2	2	148	160	124/160
5-1	22	5.7	2	149	152	132/152
5-2	35	5.7	2	147	156	123/165

-early instantaneous pressure rise
-10F/5C heat rise
-As high a pressure possible for 25 wt%
-Pressure/ramp rates less critical for 35 wt%
-data supports 1 hr hold time

Minimum Viscosity (September 2001)



Viscosity Increase With Time

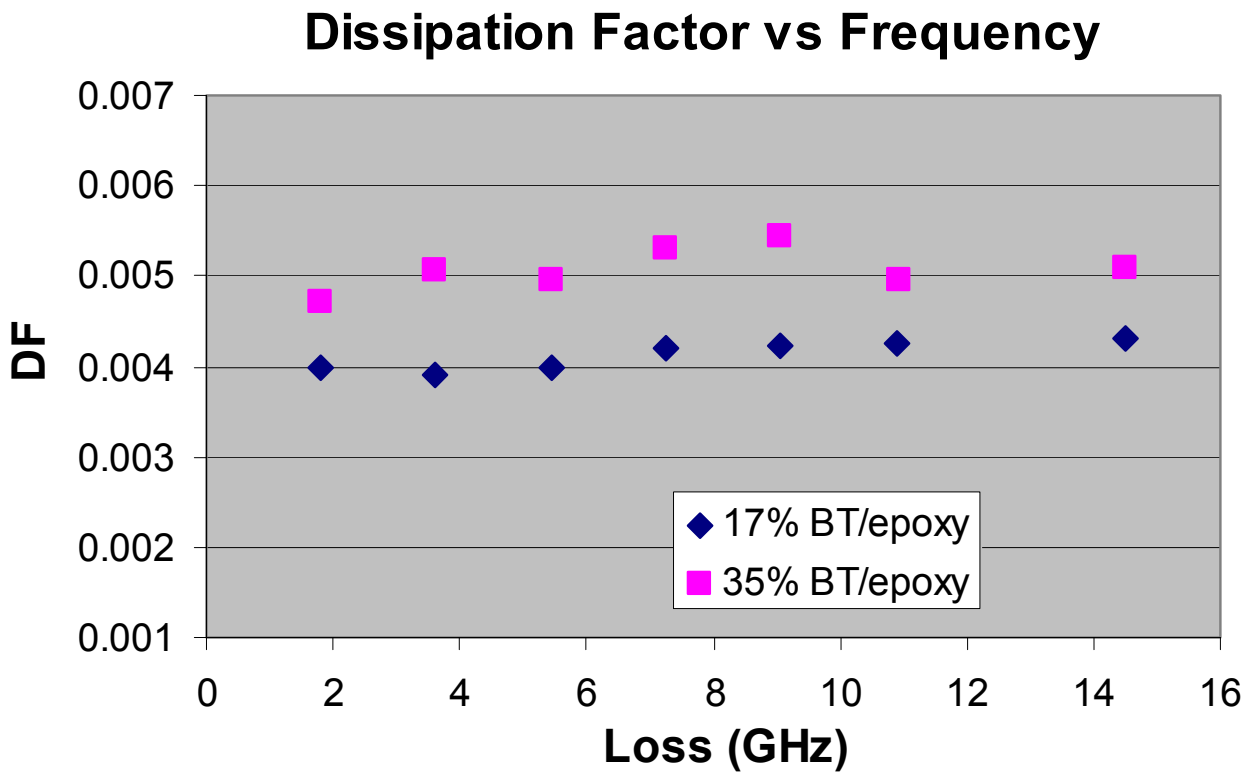


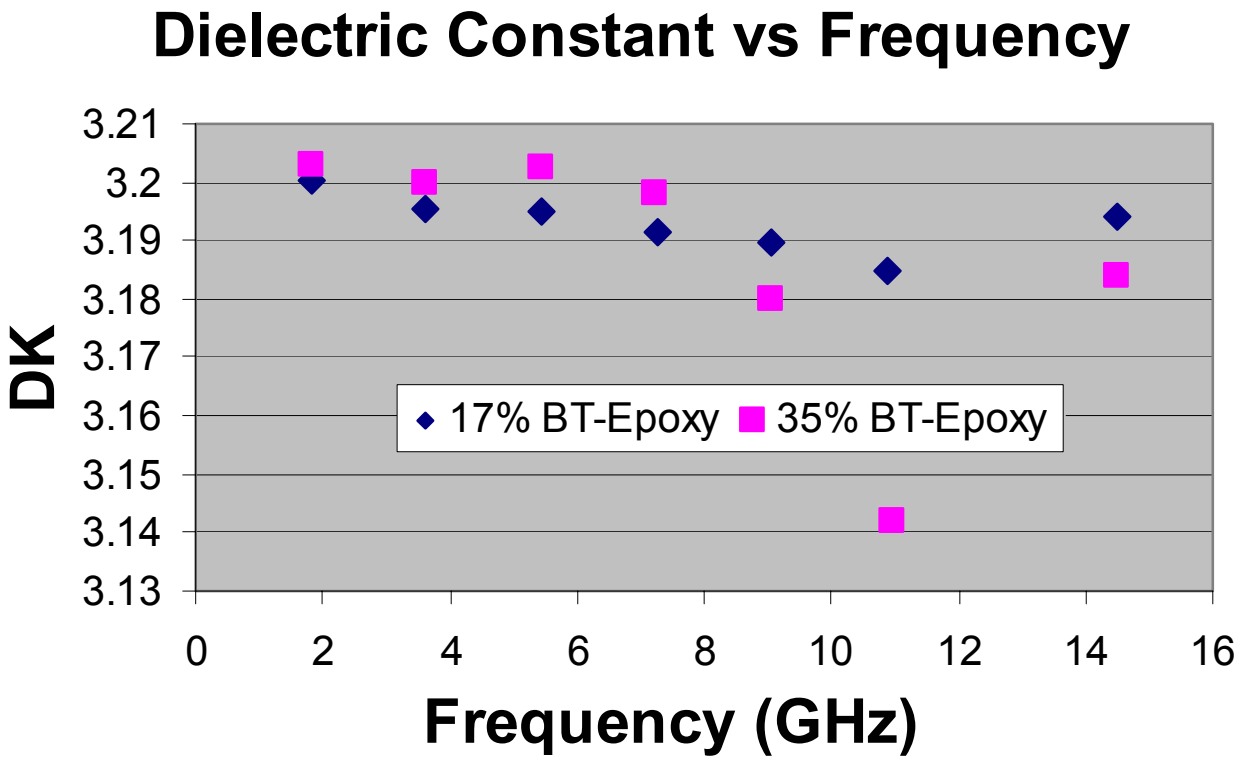
Physical Properties of PTFE/fiberglass/BT-epoxy Laminate

Property	Units	Typical Value	Method
Dielectric Constant (1 MHz, 15-35% resin)		3.20	IPC-TM 650 2.5.5
Dielectric Constant (10 GHz, 15-35% resin)		3.19	Bereskin[1]
Dissipation Factor (1 MHz, 15% resin)		0.0022	IPC-TM 650 2.5.5.5
Dissipation Factor (14.5 GHz, 15% adhesive)		0.004	Bereskin[1]
Dissipation Factor (14.5 GHz, 35% adhesive)		0.004-.005	Bereskin[1]
Peel Strength (warp) 0.5 oz reverse treated foil	lbs	5.6	IPC-TM 2.4.8
Peel Strength (fill) 0.5 oz reverse treated foil	lbs	6.4	IPC-TM 2.4.8
Moisture Absorption	(%)	0.1	IPC-TM 650 2.6.2.1
T260/T288/T300	min	>600/>60/>30	IPC-TM-650 2.4.24.1
PTFE:Epoxy ratio		5:1	
Glass Transition	(°C)	Room Temperature	(TMA)
Glass Transition	(°C)	Non-detectable 128, 177 150-160	(DSC) (DMA) (TMA)
Resin Flow (15% adhesive)	(%)	0.5-1.0	IPC – TM 650 2.3.17
Resin Flow (25% adhesive)	(%)	6.0-7.0	IPC – TM 650 2.3.17
Resin Flow (35% adhesive)	(%)	10-14.0	IPC – TM 650 2.3.17
UL ratings		In progress	

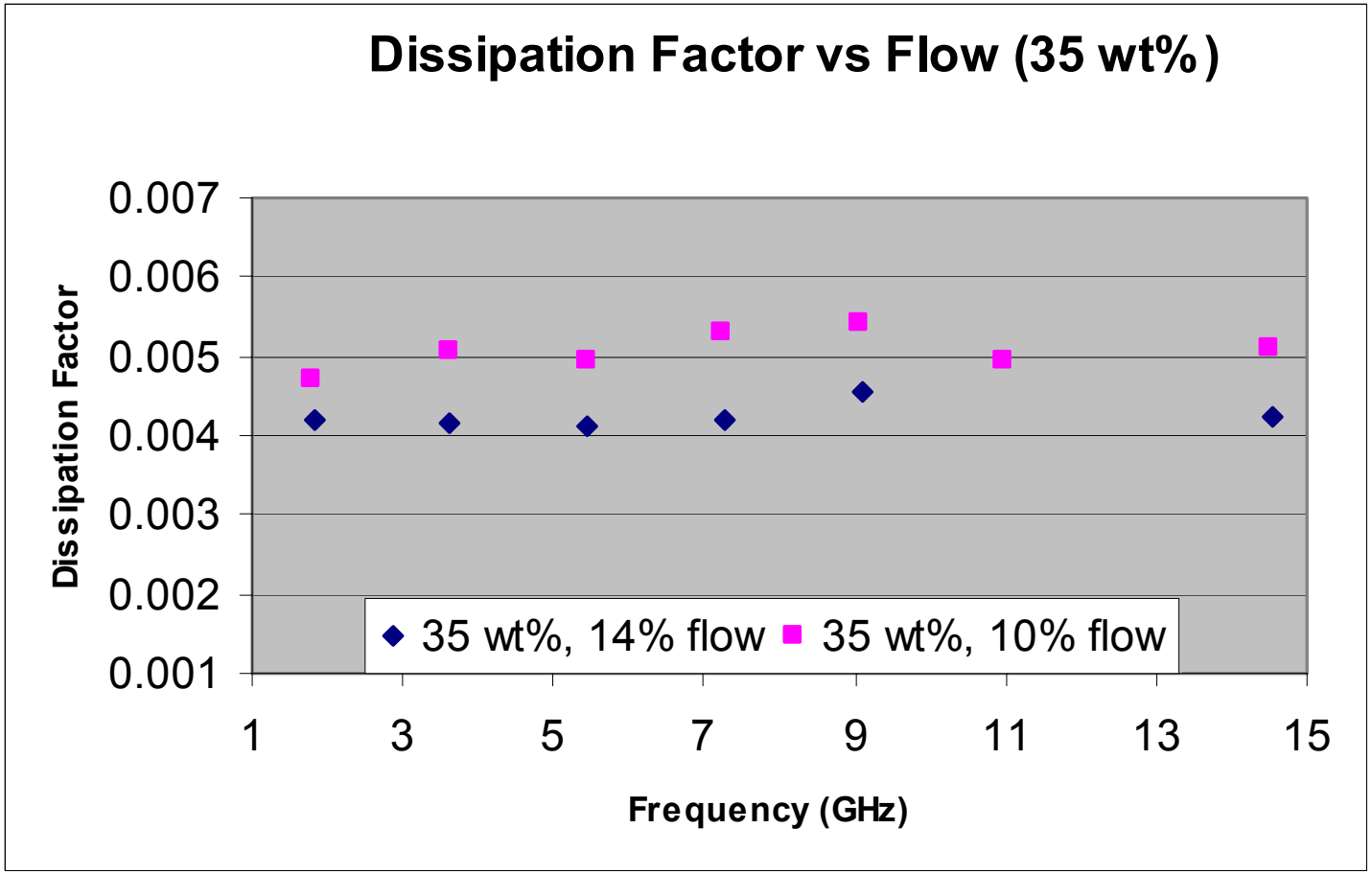
[1] (Bereskin Patents 5,083,088 and 5,187,443)

DF vs Frequency for PTFE/Fiberglass/BT-epoxy hybrids with varying BT content

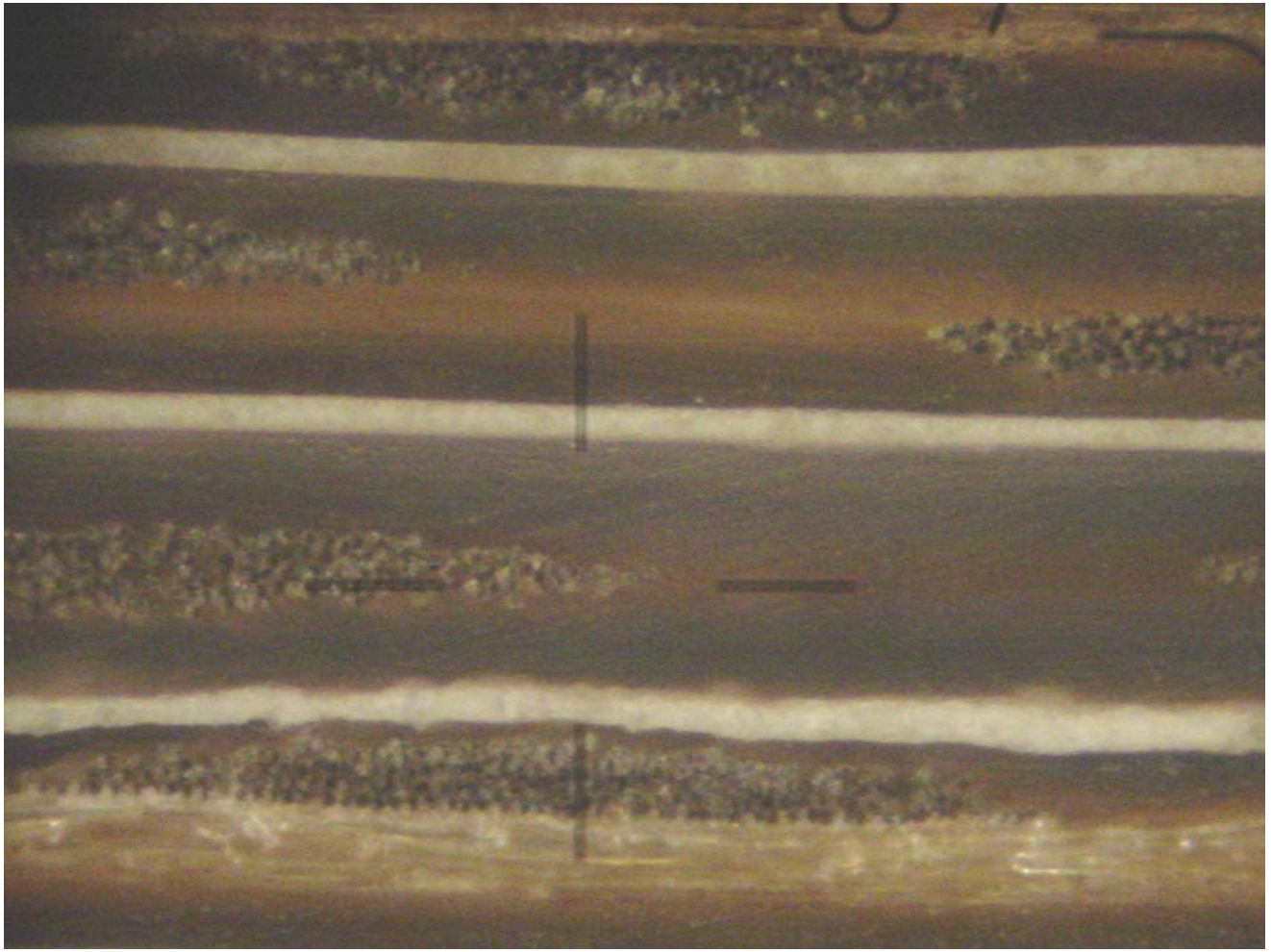




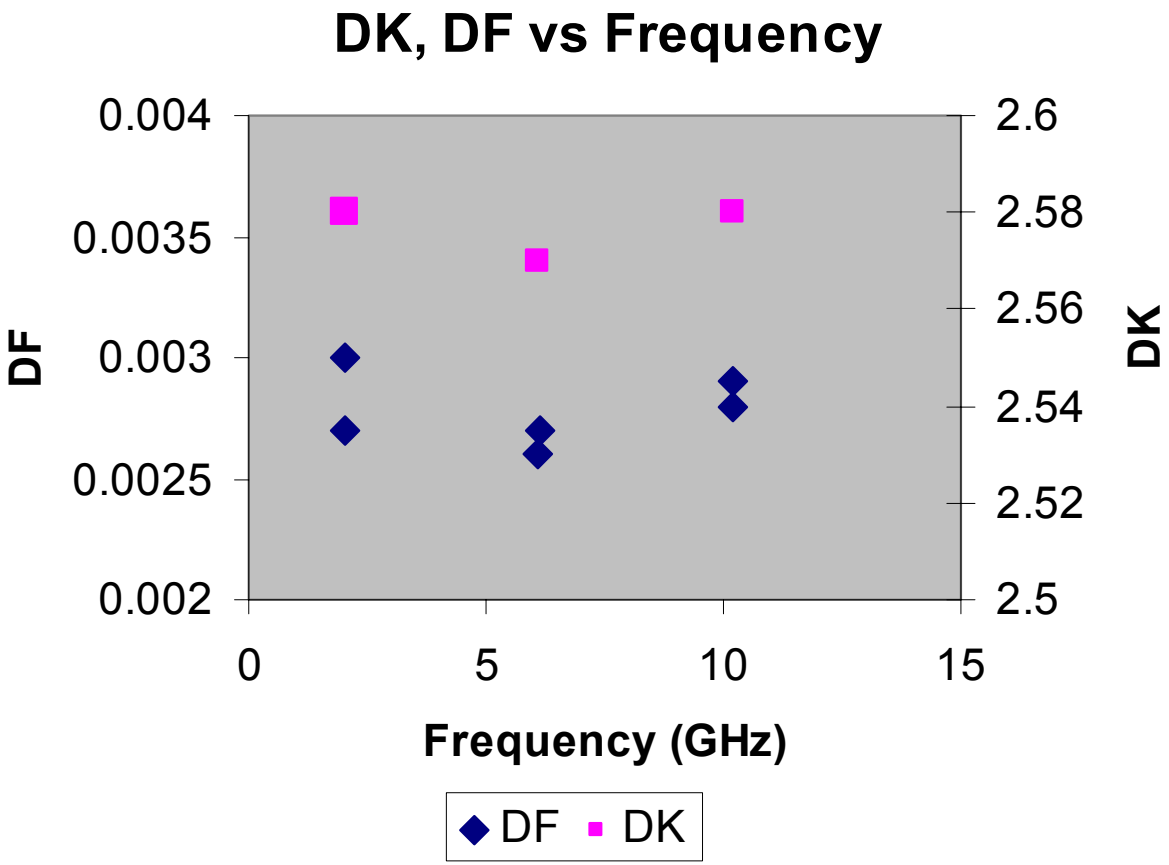
Loss and Flow



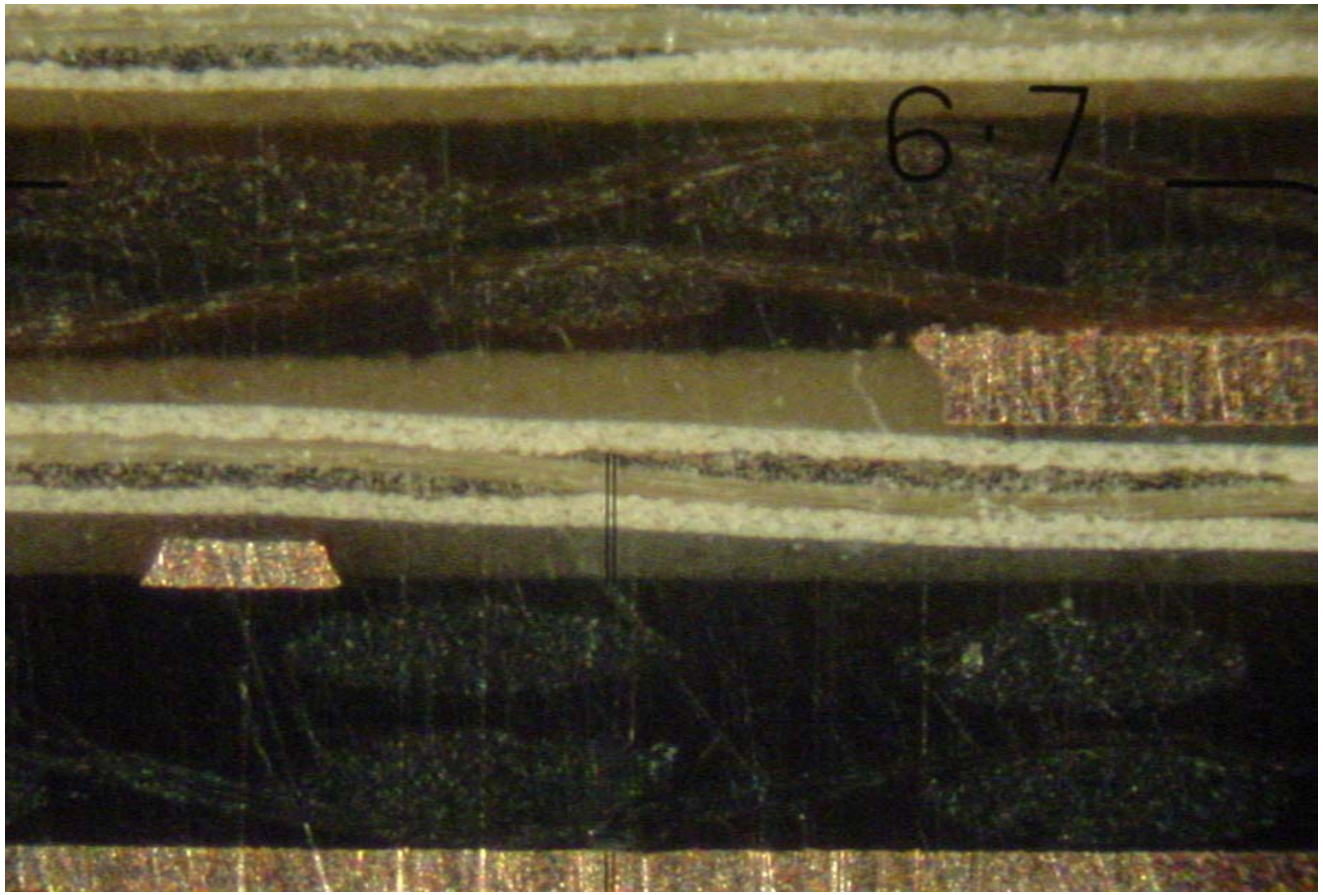
PTFE/fiberglass/ceramic filled thermoset having high PTFE content



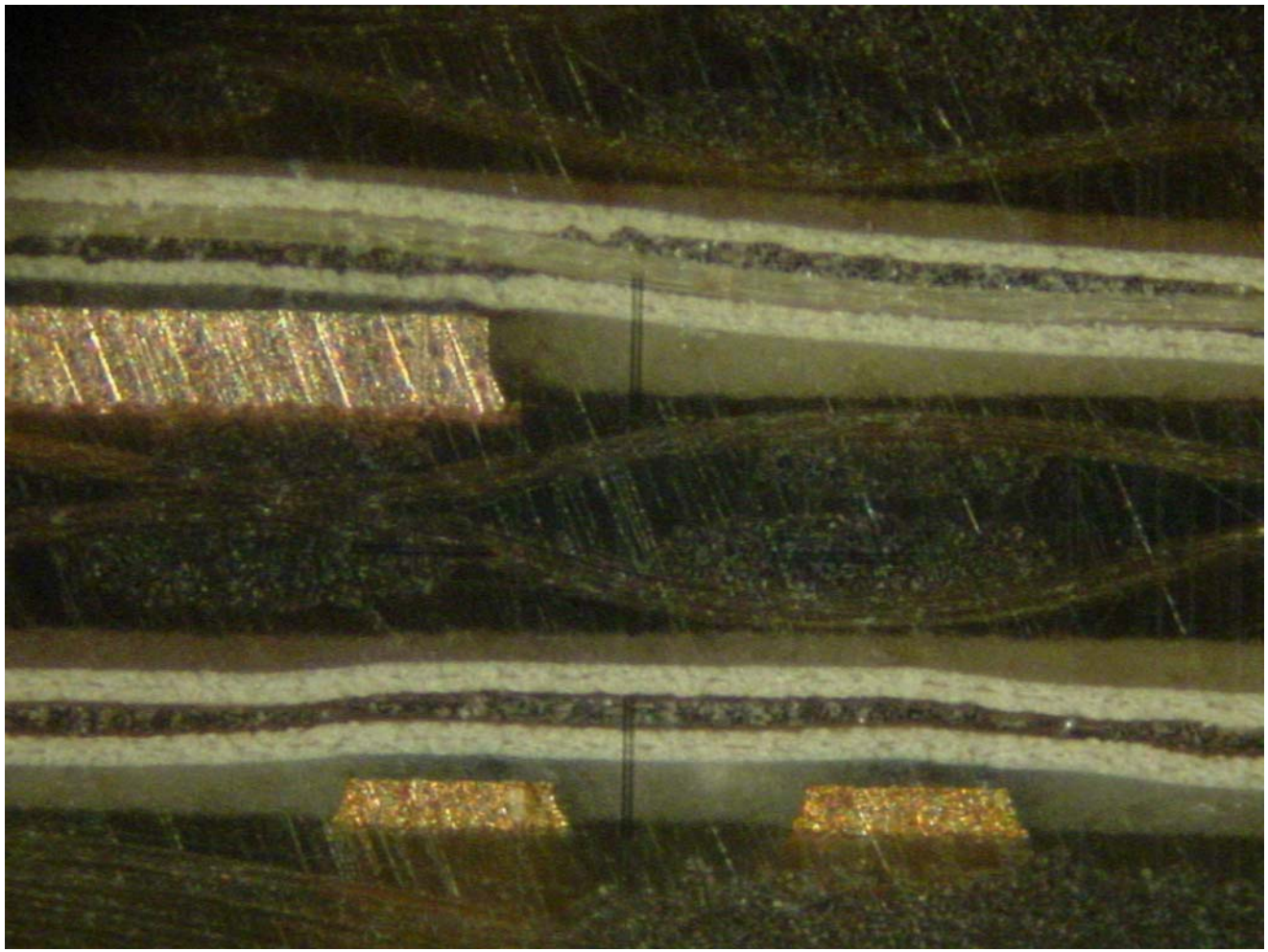
PTFE/fiberglass/BT-epoxy composite having a high PTFE content



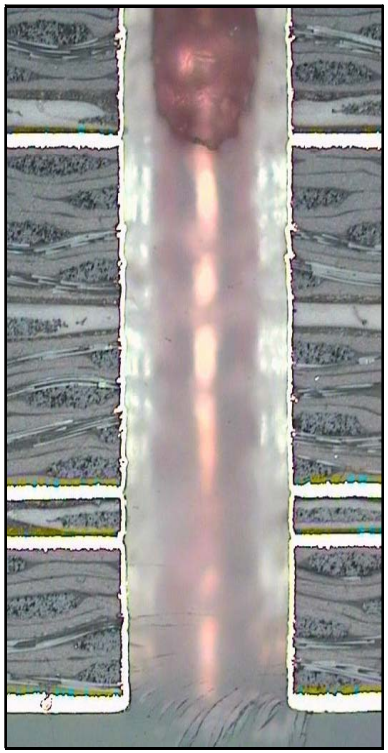
PTFE/Fiberglass/BT-epoxy conforming to 1&2 oz Circuitry (Heat Rise 2C/min)

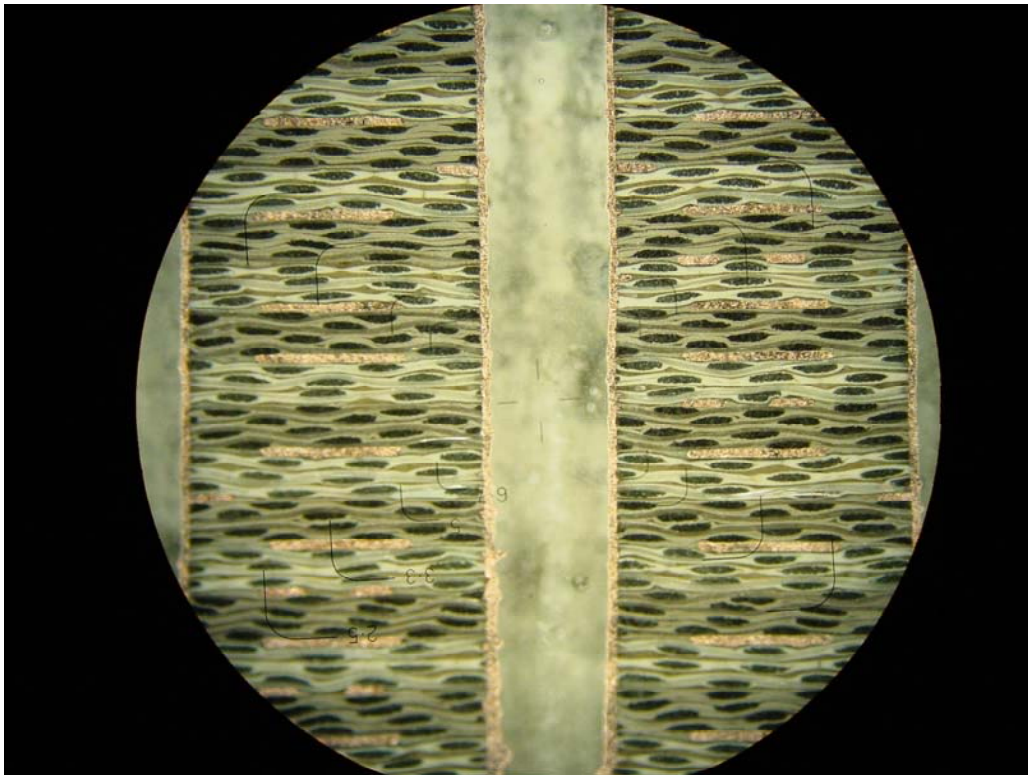


PTFE/Fiberglass/BT-epoxy conforming to 1&2 oz Circuitry (Heat Rise 5C/min)

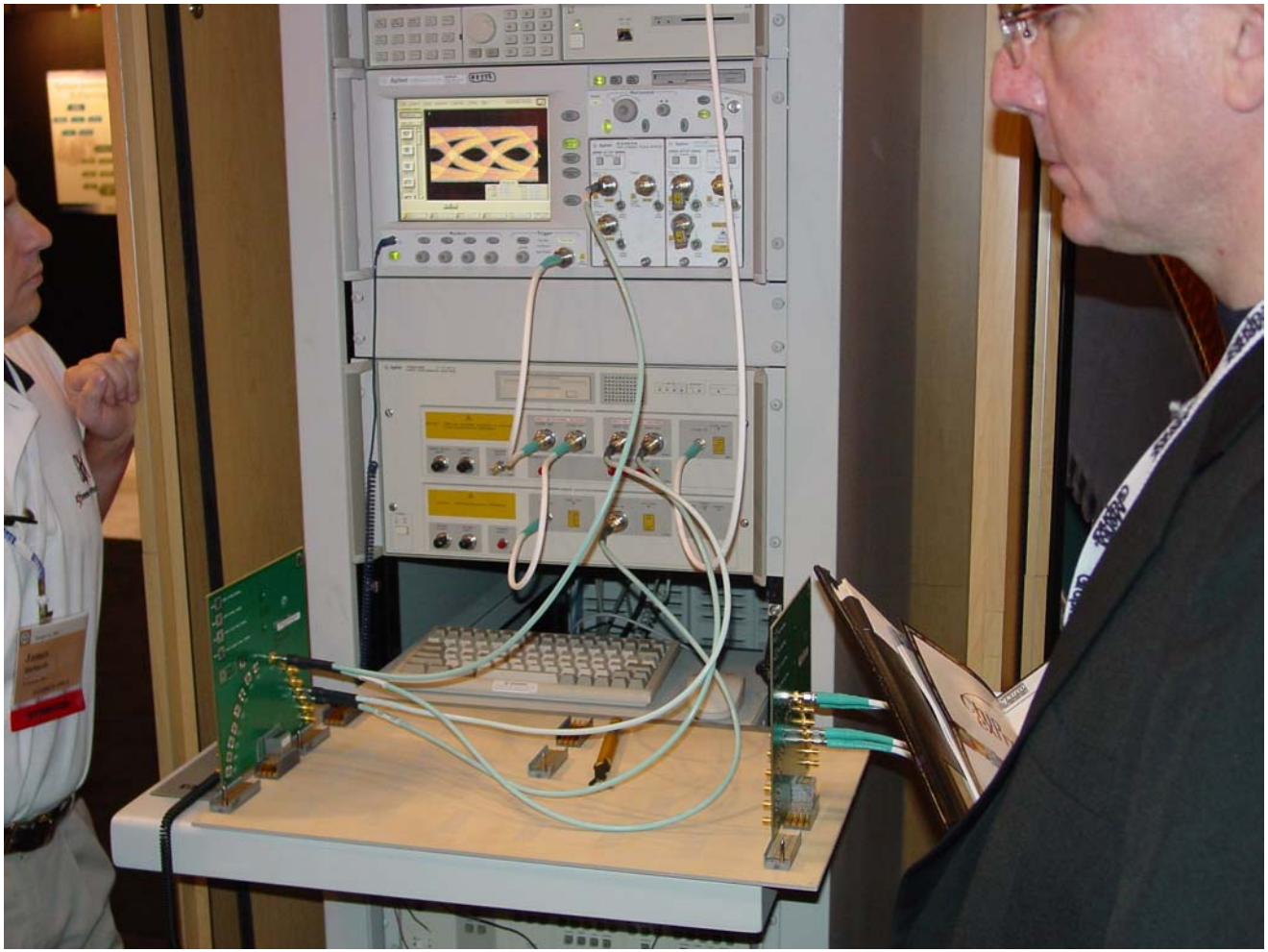


Multilayer buildups using PTFE/fiberglass/BT-epoxy composites

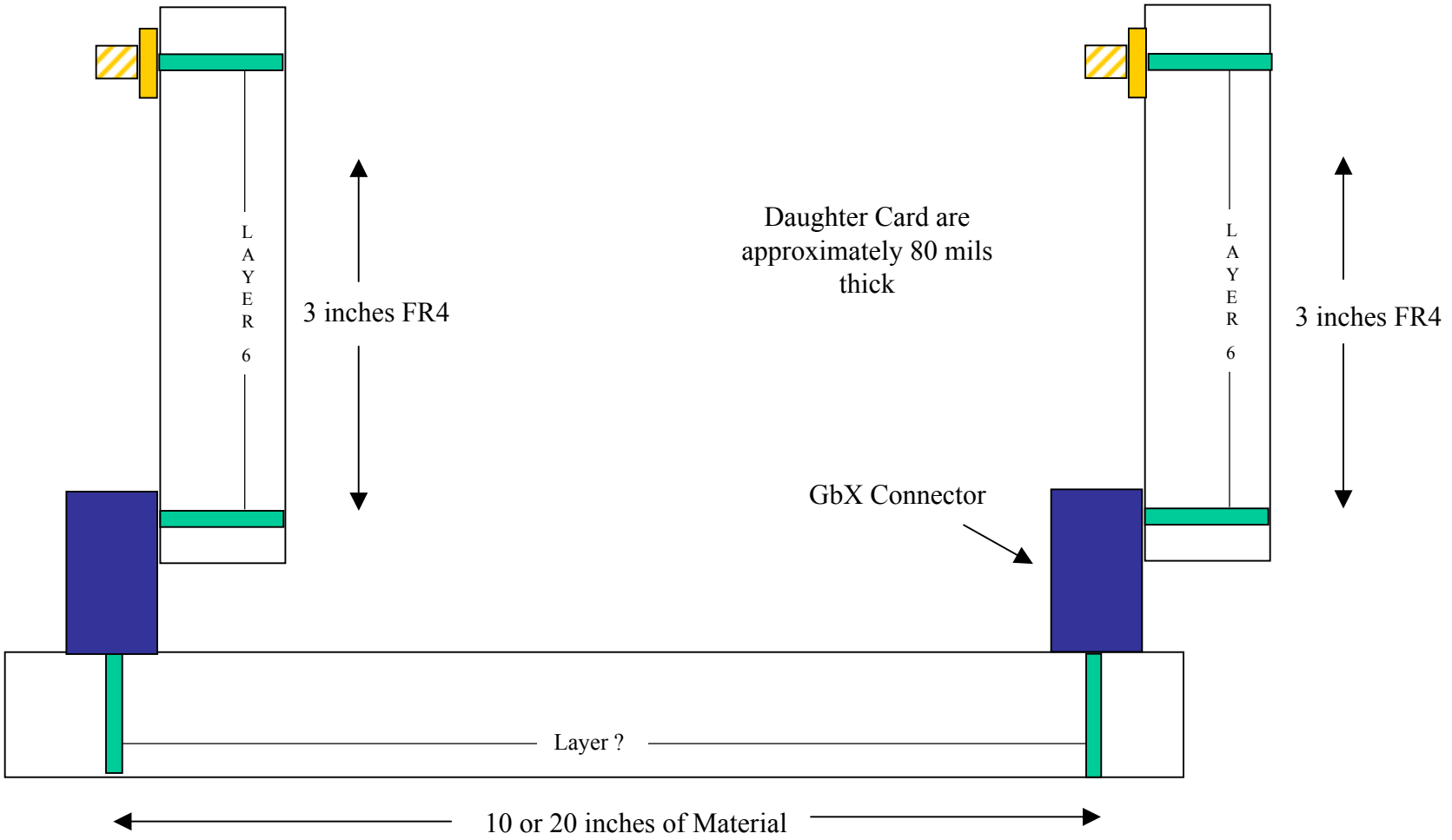




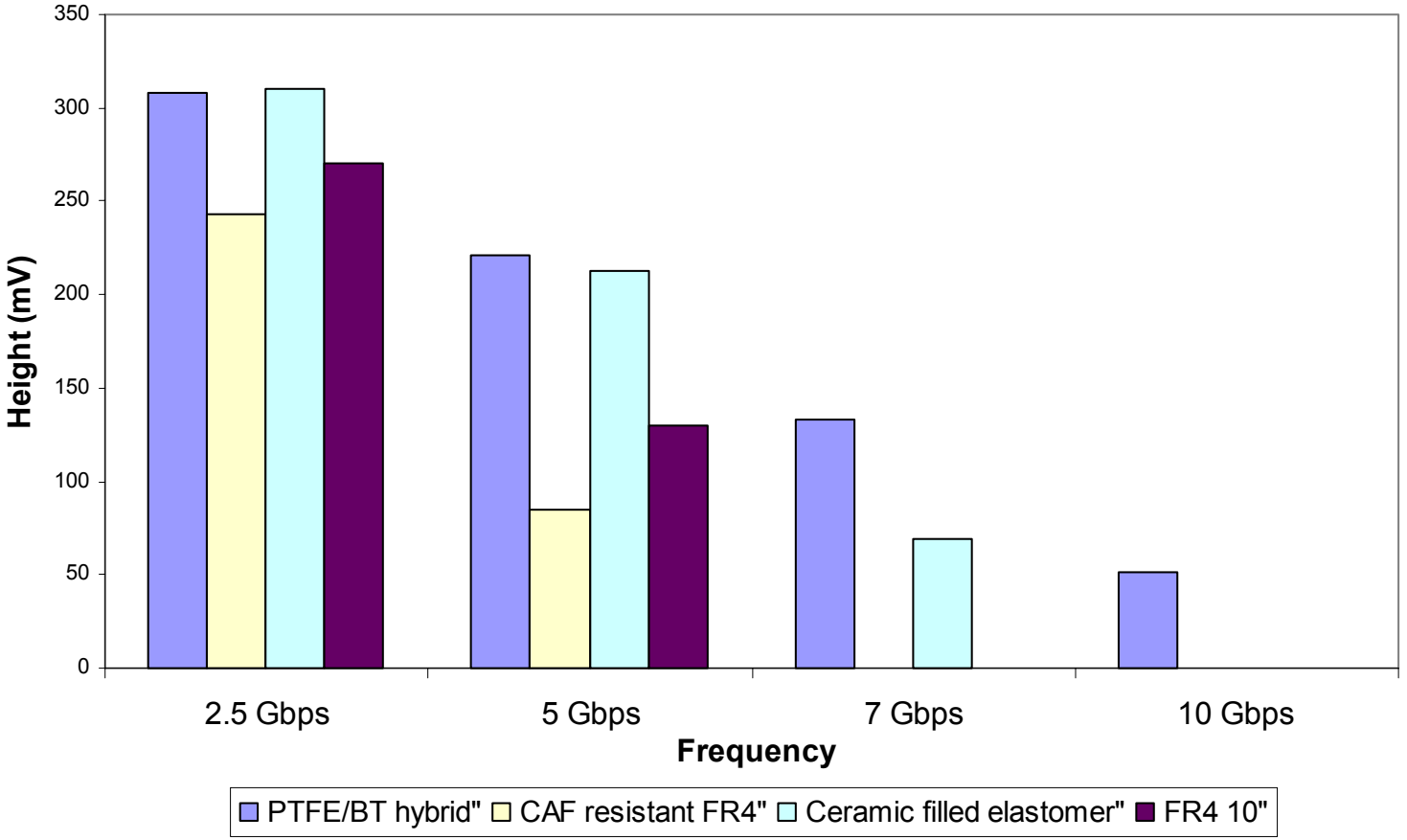
DesignCon 2002
Signal Integrity Measurements
(40 in/101 cm long traces, 2.5 gbps)



Test Board Setup

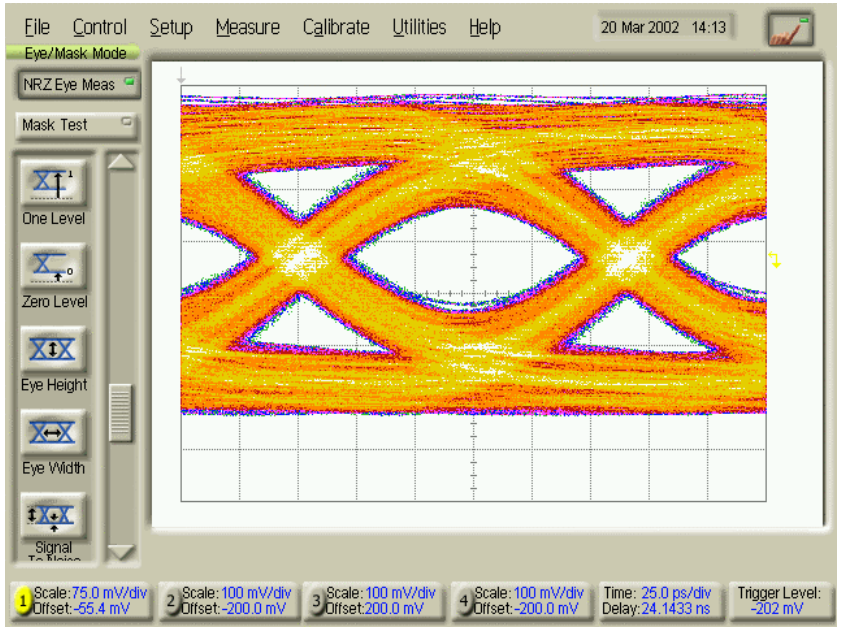


Eye Height Material Comparison at 10 inches

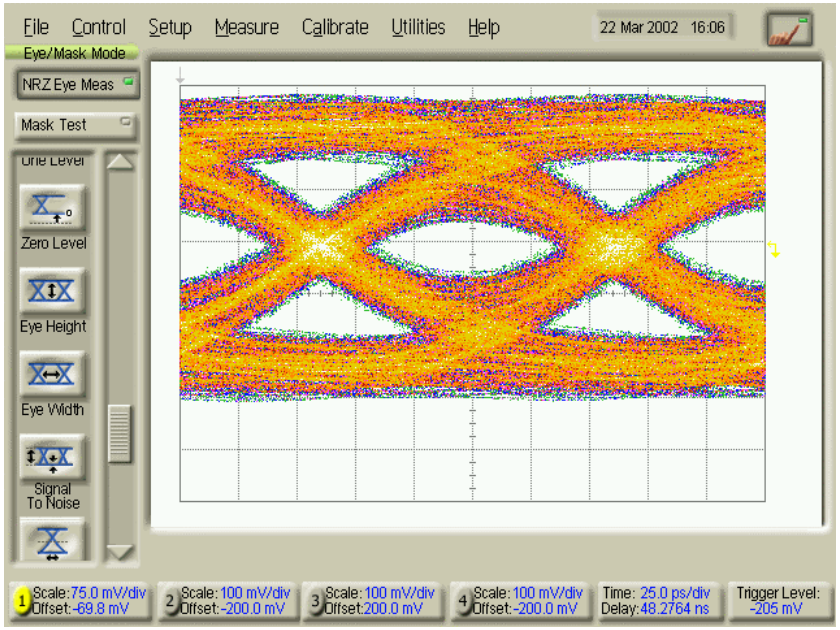


Signal Integrity Measurements of various 20 layer test vehicles (10 Inches at 7.5 Gbps)*

PTFE/fiberglass/BT-epoxy hybrid



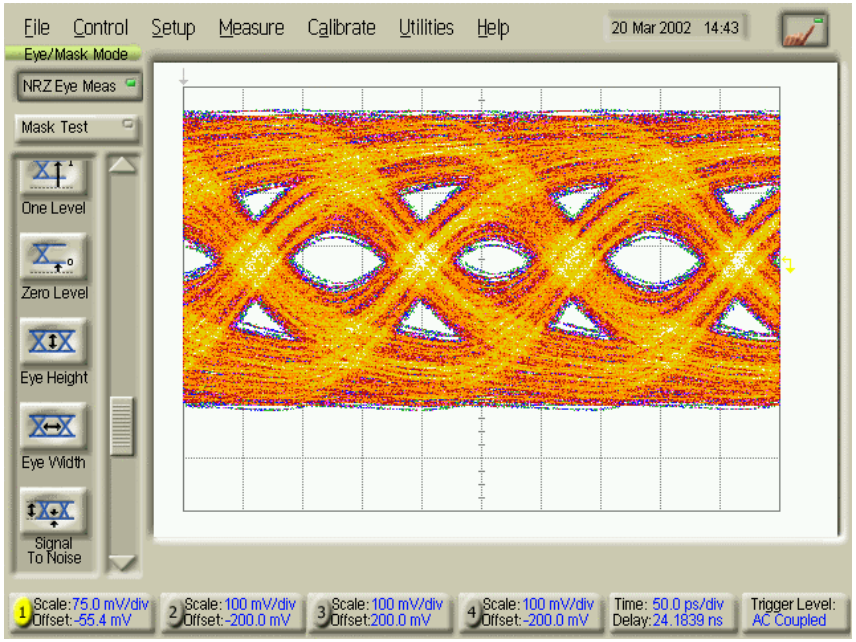
Ceramic filled elastomer



*Compliments of Teradyne Connection Systems

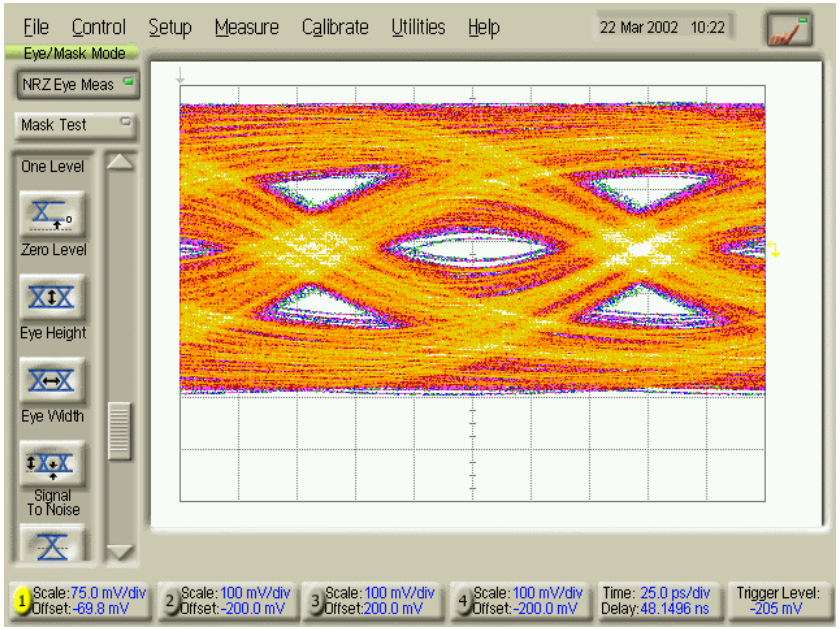
Signal Integrity Measurements of various 20 layer test vehicles (20 Inches at 7.5 Gbps)*

PTFE/Fiberglass/BT-epoxy



Jitter = 75 ps, eye height = 58 mV

Ceramic filled elastomer



Jitter = 90 ps, eye height = 33 mV

*Compliments of Teradyne Connection Systems

PTFE/fiberglass/thermoset Joint Development

Overcomes volume constraints of PTFE processing (3 hour BT-epoxy cycle vs 9 hour PTFE cycle) - reduces cost

Takes advantage of the high volume lamination infrastructure - reduces cost

Leverages the core competencies of the respective companies

Greatly expands the resin systems that can be combined with a PTFE substrate

Resolves supply chain issues