High Layer Count Backpanels Operating at 10 Gb/s Enabled by PTFE-based Composites

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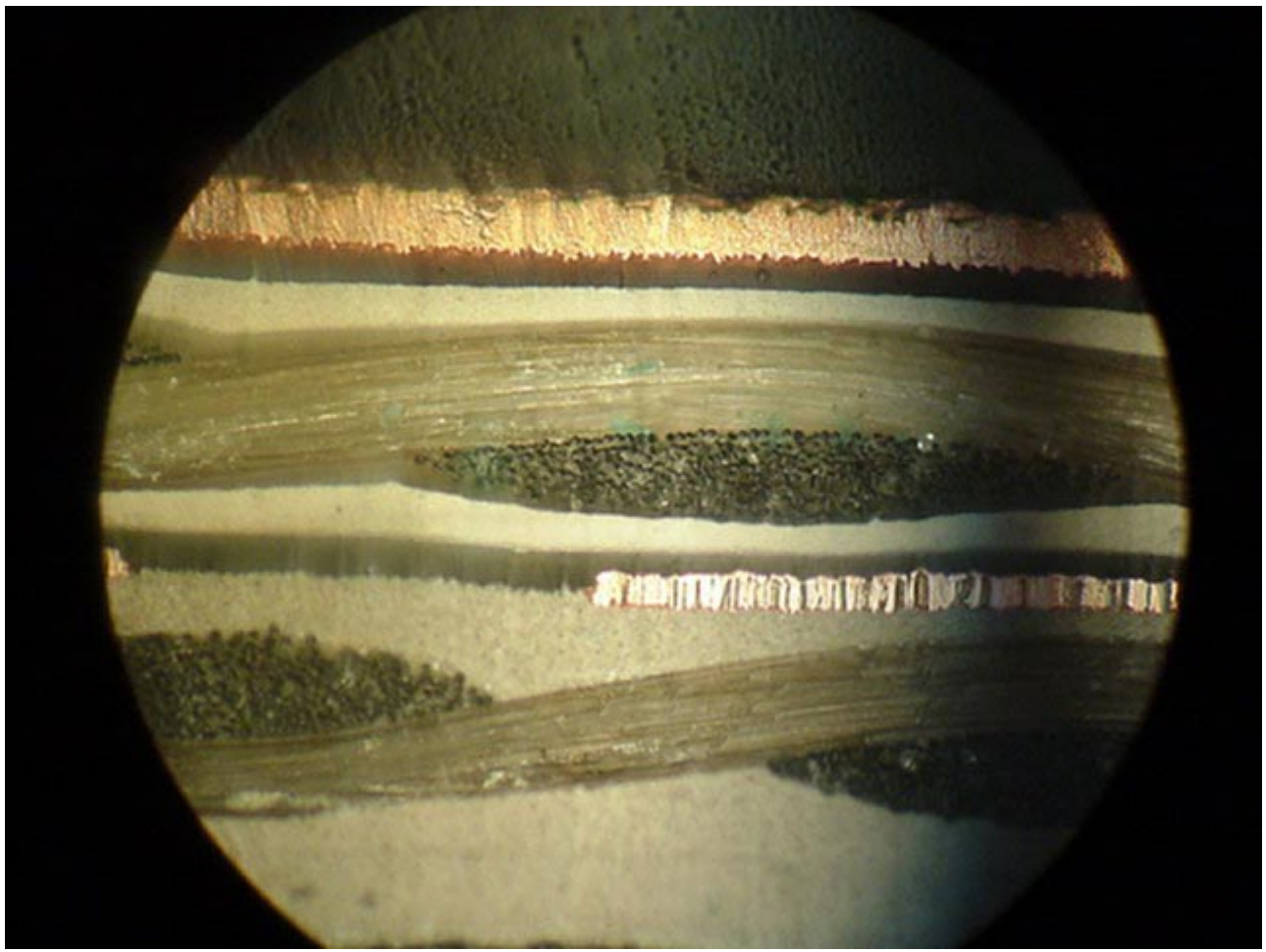
a glimpse of things to come …



Today's Base Materials

1 Gb/s:	FR4
2.5 Gb/s:	PPO/PPE-epoxy/glass, elastomer/ceramic/glass
> 2.5 Gb/s:	?

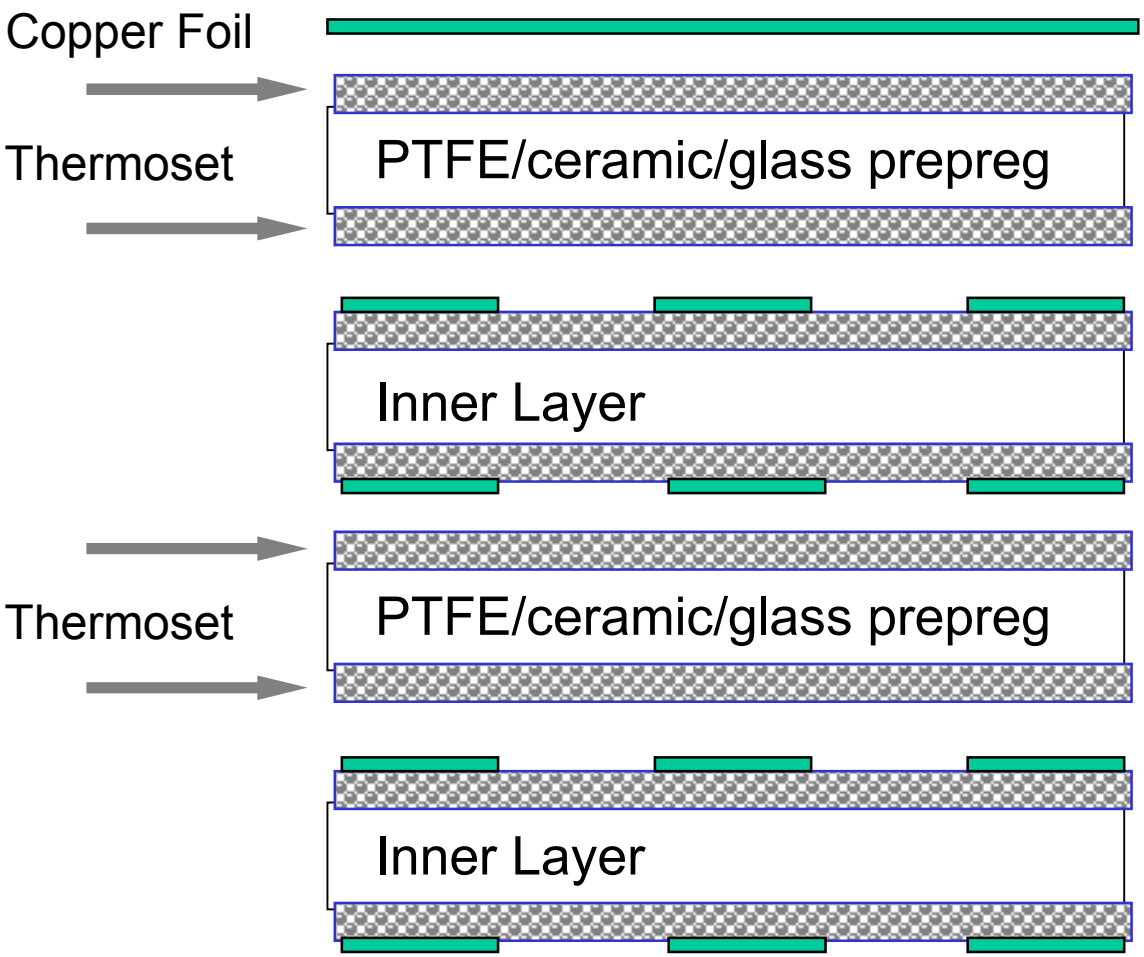
High-Speed Digital & WCDMA

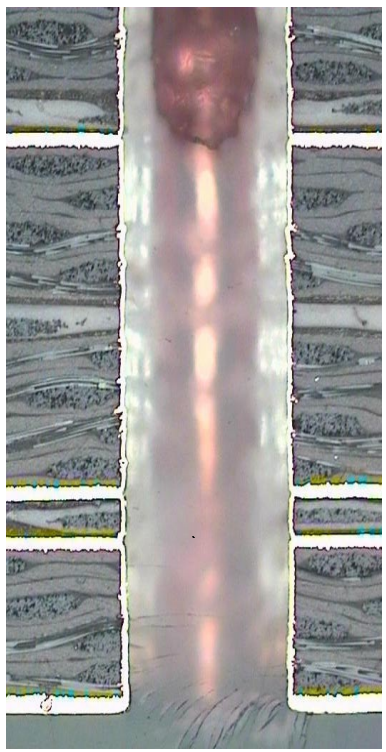
High layer count Multilayers
for High-Speed Digital and WCDMA
require a new Base Material Platform on
Fluoropolymer basis
for Laminate **and** Prepregs

PTFE/glass fabric/thermoset resin hybrid

(patent pending)

The Taconic approach:





Requirements for Base Materials

1. Material Loss Capability at 10 Gb/s
2. Cost of PTFE-based materials
3. Manufacturability of printed circuit boards
4. Dependability of Supply

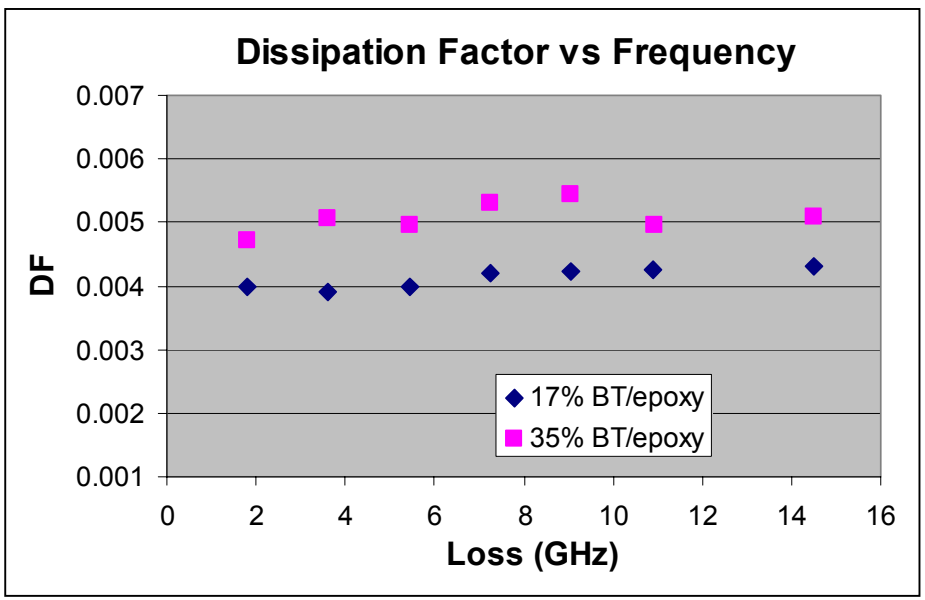
Requirements for Base Materials

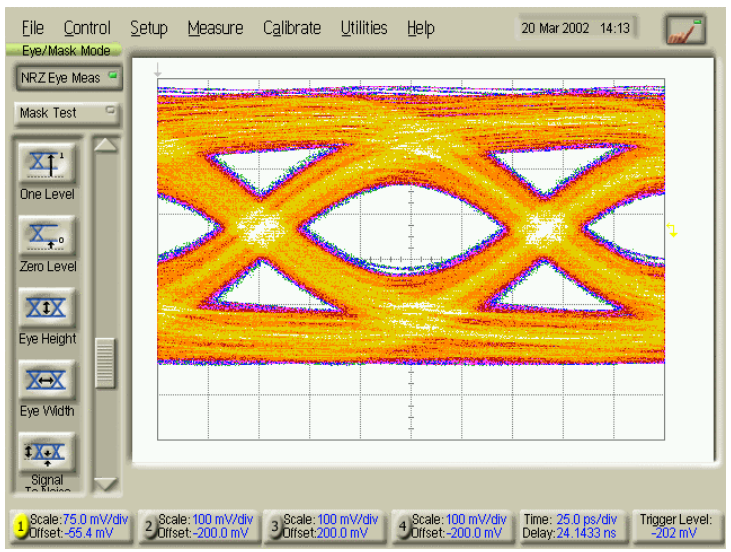
Requirement:

Material Capability at 10 Gb/s

Response:

TacPreg™ loss is flat over frequency even beyond 10 Gb/s





Requirements for Base Materials

Requirement:

Cost of PTFE-based materials

Response:

The combination of ceramic materials in the TacPreg™ matrix and higher volume manufacturing allows the product to be competitively positioned relative to other materials targeted for 10 Gb/s designs.

Requirements for Base Materials

Requirement:

Manufacturability of Printed Circuit Boards

Response:

For over a decade, Taconic has supplied production quantities of microwave PTFE laminate materials to dozens of worldwide PCB fabricators to OEM's like Nokia, Lucent and Motorola.

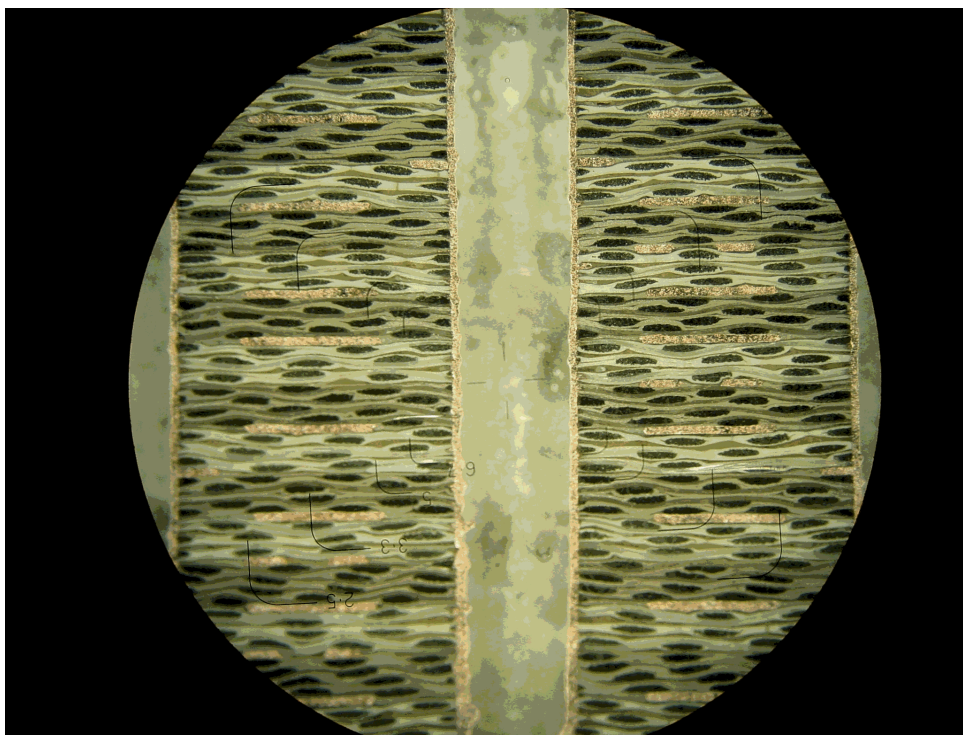
Requirements for Base Materials

Requirement:

Manufacturability of Printed Circuit Boards

Response:

For the first time, Taconic's patent-pending TacPreg™ material allows fabricators to create high-count, multilayer boards using low-loss PTFE materials.



Requirements for Base Materials

Requirement:

Manufacturability of Printed Circuit Boards

Response:

• 2 of 3 Europe's largest printed circuit board manufacturers have been delivering production quantities of a related predecessor material to TacPreg™ for more than 18 months.

• Back plane supplier Teradyne, has joined a co-manufacturing effort with Taconic to rapidly qualify the materials for high layer count applications.

• During the second half of 2002 additional printed circuit board manufacturers across the globe, familiar with Taconic's RF-35 material, will be qualifying TacPreg™.

Requirements for Base Materials

Requirement:

Dependability of Supply

Response:

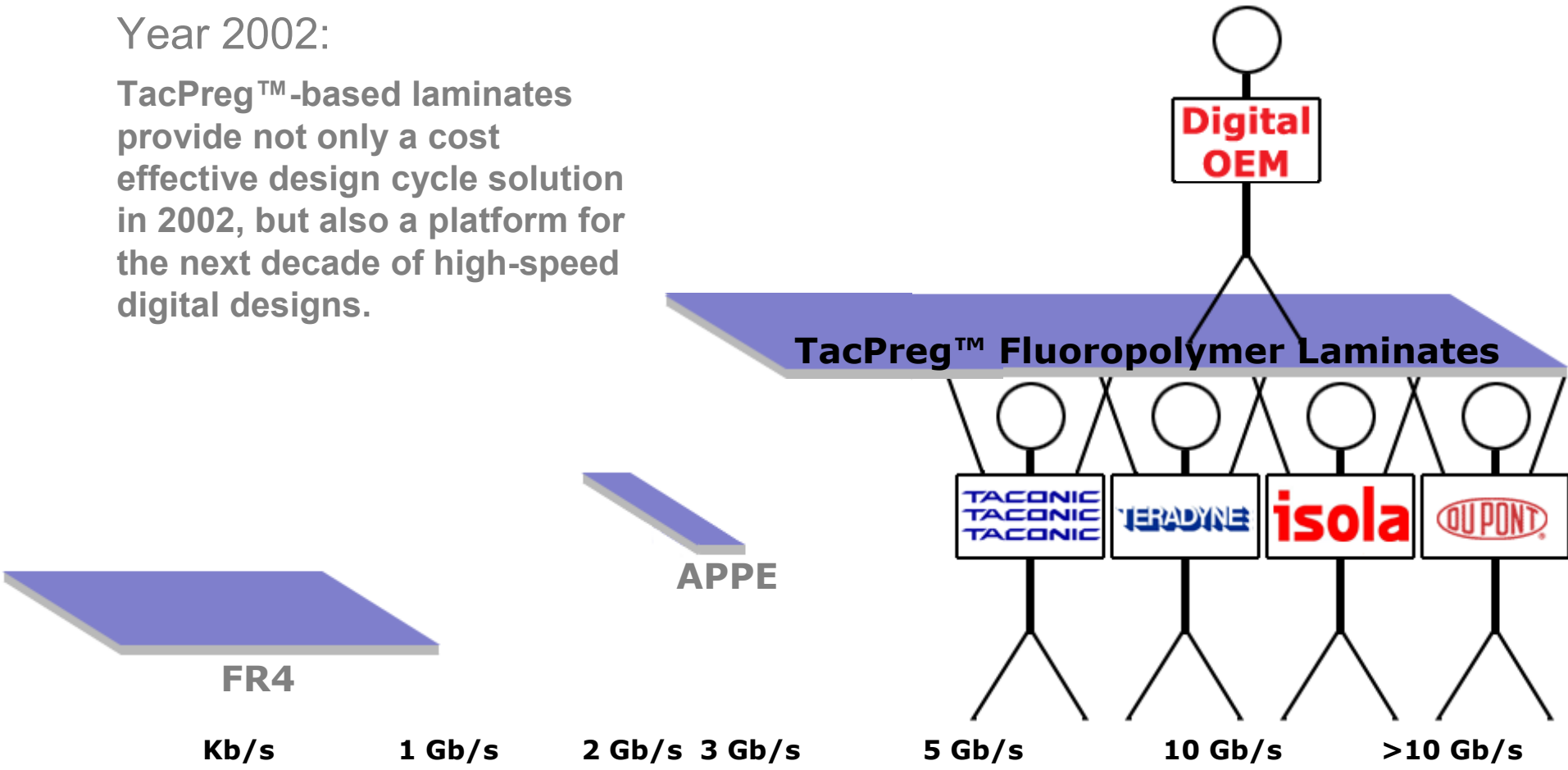
Unlike former point solutions, Taconic has licensed TagPreg™ manufacturing capability before demand outstrips supply.

Taconic:	High-Speed Digital: TacLam™3200 & TacPreg™
	RF/Microwave: RF-35 and RF-35P & TacPreg™
Isola:	IS630

High Speed Digital Material Platform

Year 2002:

TacPreg™-based laminates provide not only a cost effective design cycle solution in 2002, but also a platform for the next decade of high-speed digital designs.



PTFE/Glass Fabric/Thermoset Approach

Allows flexibility to modify system with regard to loss, DK, CTE, etc.

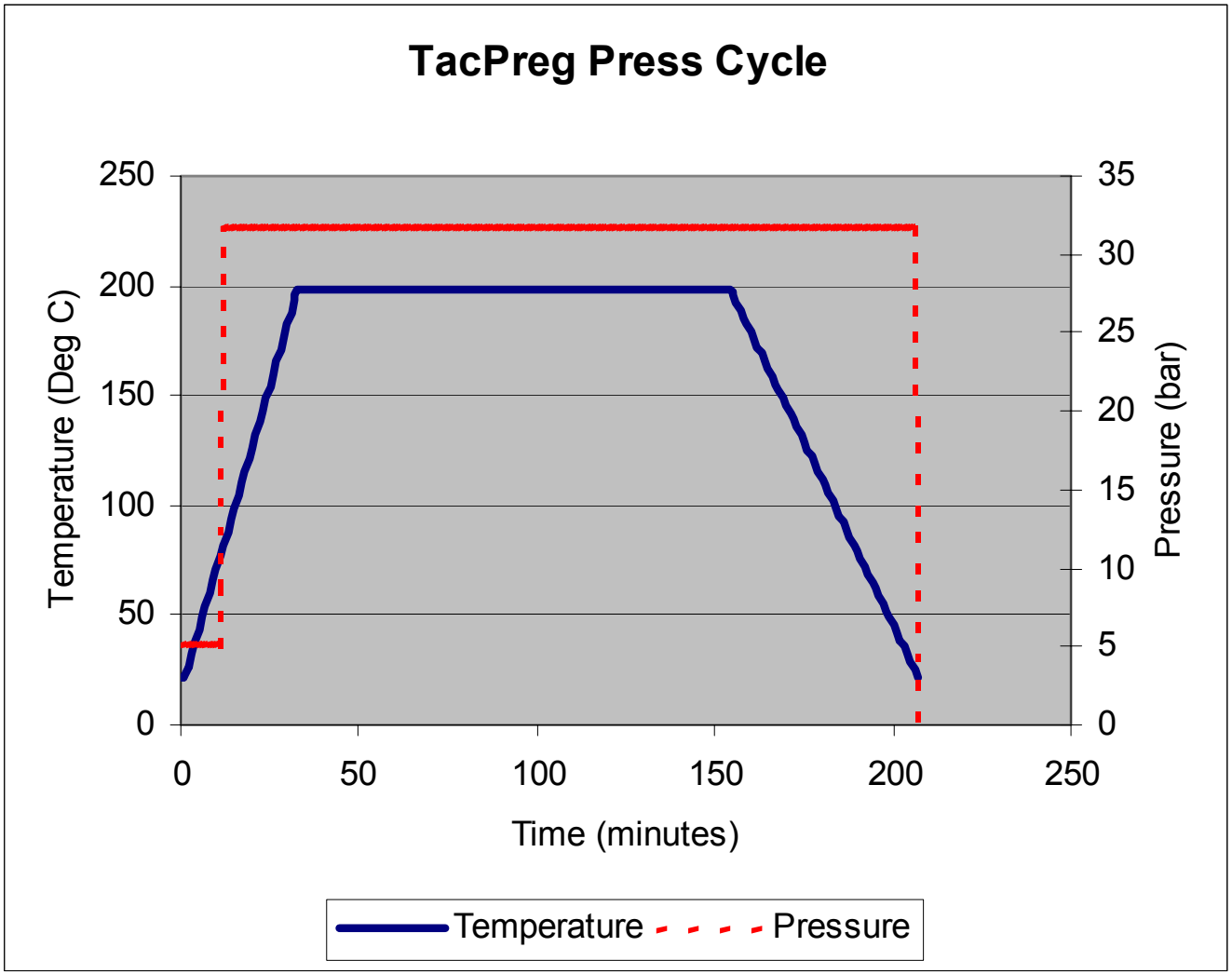
- **PTFE/Glass Fabric**
  - low loss
  - low moisture absorption
  - good dimensional stability
  - predictable movement
  - no flame retardant for V-0
  - very high thermal stability
  - growing fabricator base
  - low risk
- **BT-Epoxy**
  - used as an adhesive layer only
  - highest loss component fills gaps and excess squeezes out
  - can be minimized for laminate cores
  - improves the drill performance of standard PTFE/glass composites
  - provides robust bonding to copper and inner layers
  - degree of flow can be readily adjusted

Physical Properties of PTFE/Glass/BT-epoxy Laminate

Property	Units	Typical Value	Method
Dielectric Constant (1 MHz, 15-35% BT resin)		3.20	IPC-TM-650 2.5.5.3
Dielectric Constant (10 GHz, 15-35% BT resin)		3.19	Bereskin
Dissipation Factor (1 MHz, 15% BT resin)		0.0022	IPC-TM-650 2.5.5.5
Dissipation Factor (14.5 GHz, 15-35% BT resin)		0.004-0.005	Bereskin
Peel Strength (warp, fill) 0.5 oz reverse treated foil	lbs (N/mm)	>5.6 (>0.98)	IPC-TM-650 2.4.8
Peel Strength (warp, fill) 0.5 oz standard foil	lbs (N/mm)	8 (1/4)	IPC-TM-650 2.4.8
Moisture Absorption	(%)	0.1	IPC-TM 650 2.6.2.1
T260/T288/T300	min	>600/>60/>30	
Glass Transition	(◦C)	Non-detectable	(DSC)
UL Relative Thermal Index		140-150◦C*	
Resin Flow **	(%)	1-14	IPC-TM-650 2.3.17

(Bereskin Patents -US 5,083,088 and 5,187,443)
*Expected RTI based on UL screening
** Only BT.epoxy flow; PTFE remains

TacPreg Press Cycle



Multilayer

1080 TacPreg™

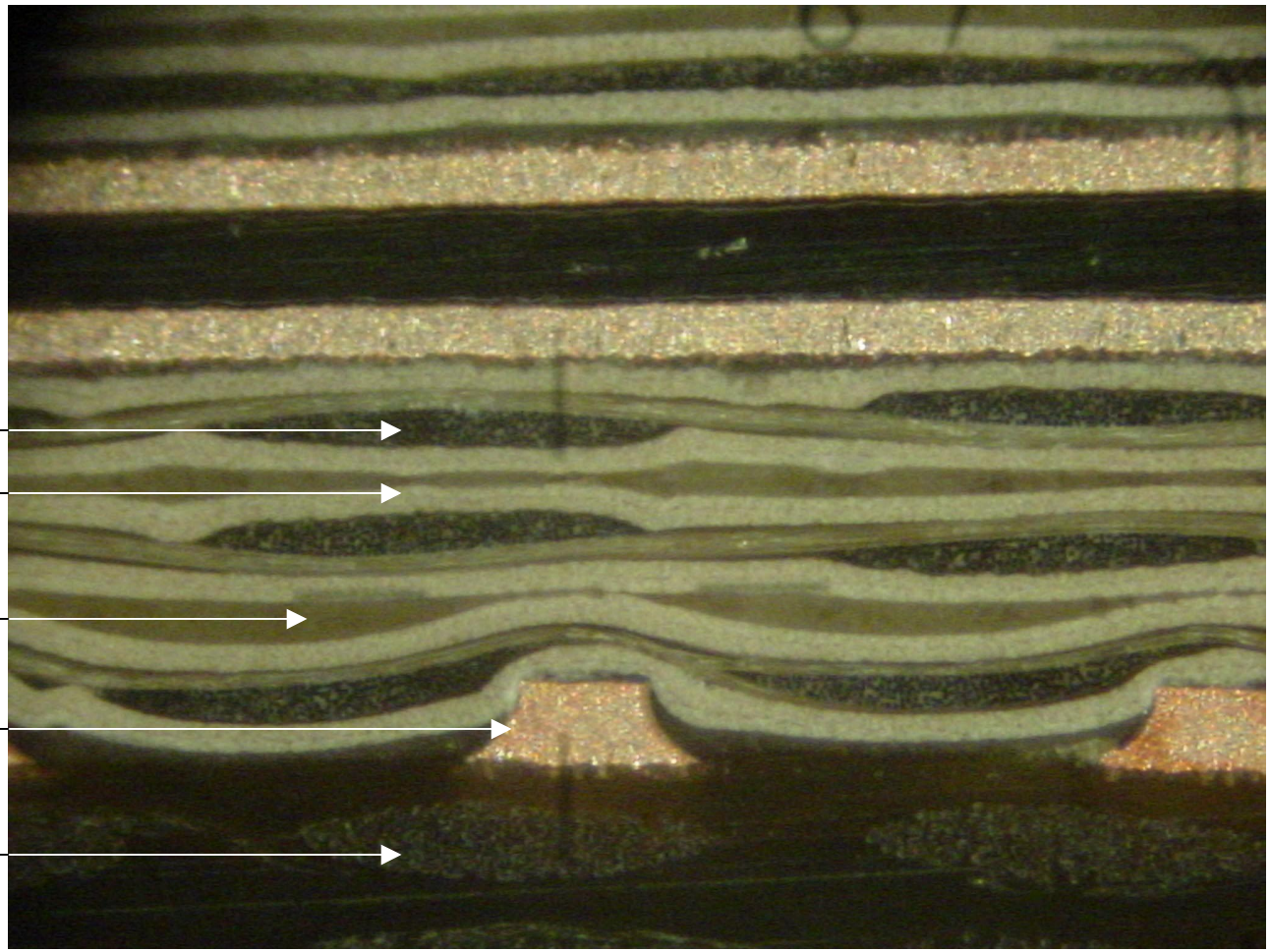
Glass

Ceramic

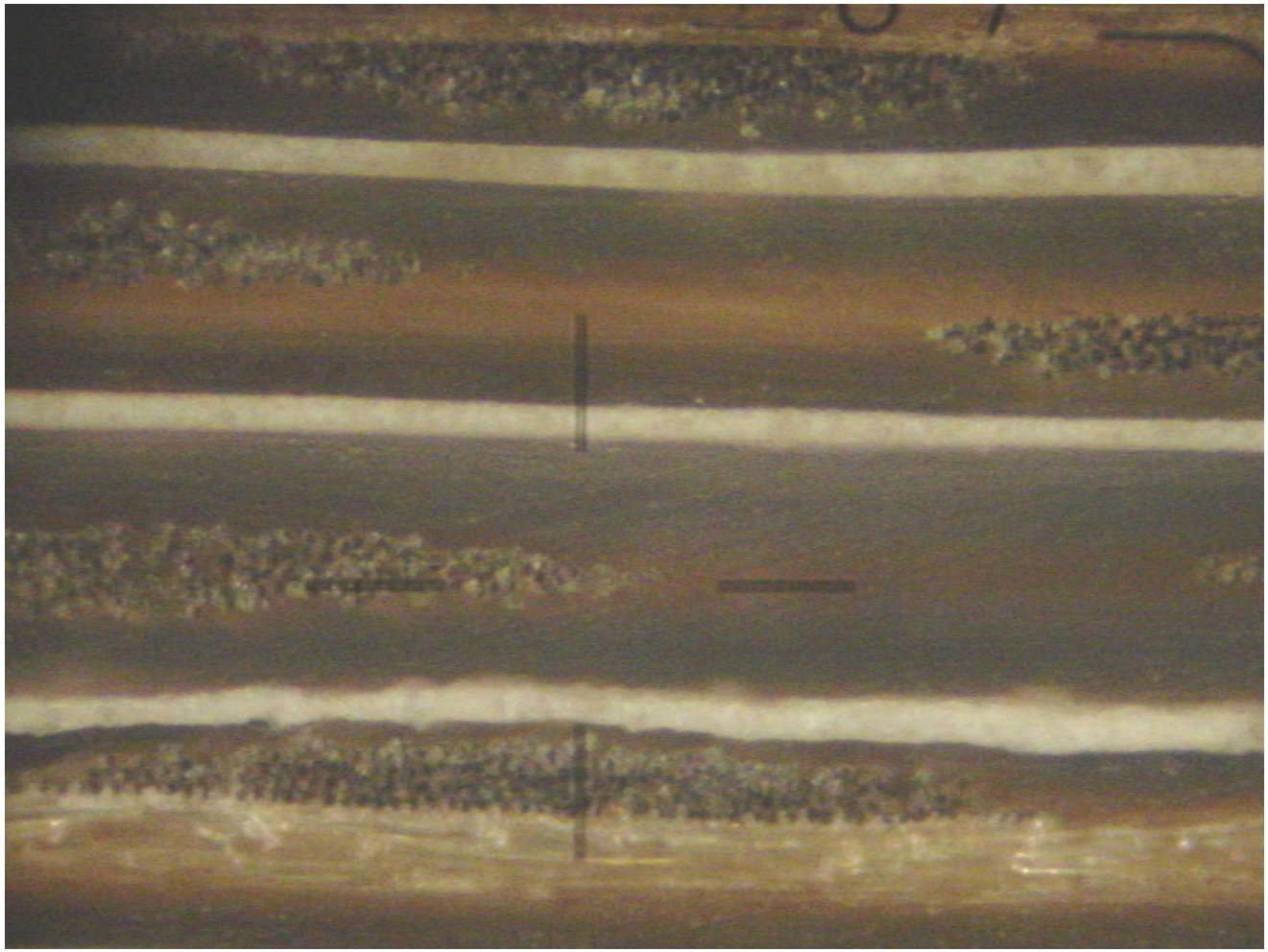
Thermoset Resin

70 micron track

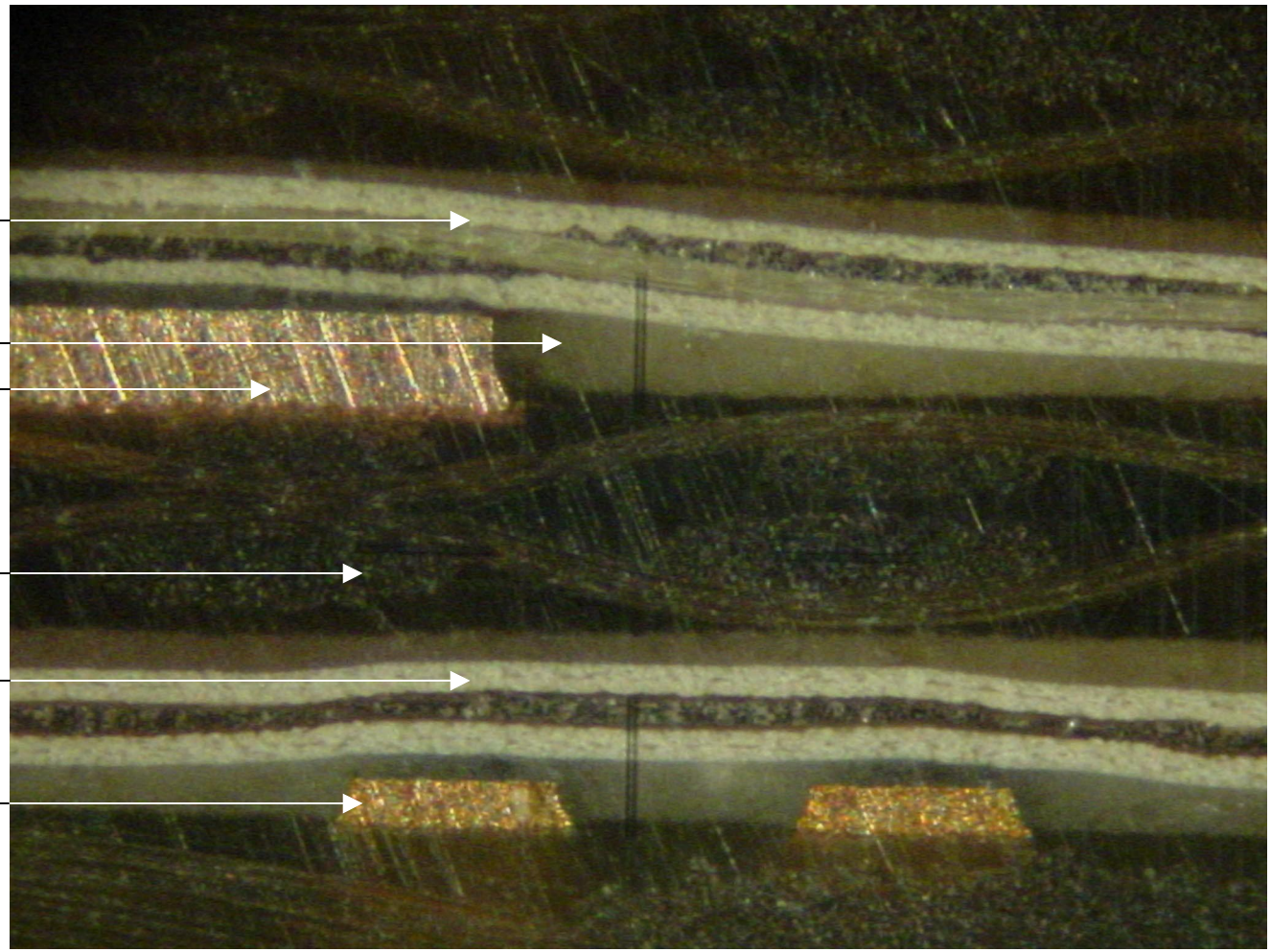
RF-35P



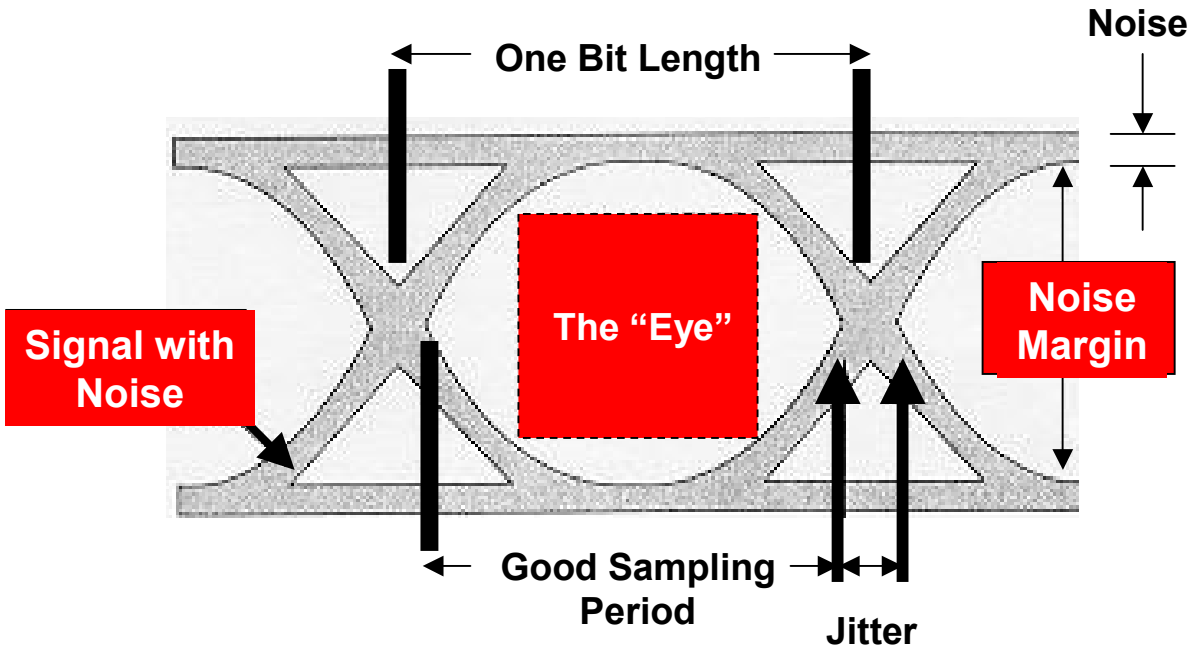
PTFE/Glass Fabric/Ceramic filled BT-epoxy laminate



PTFE/Glass Fabric/BT-epoxy conforming to 1&2 oz Circuitry



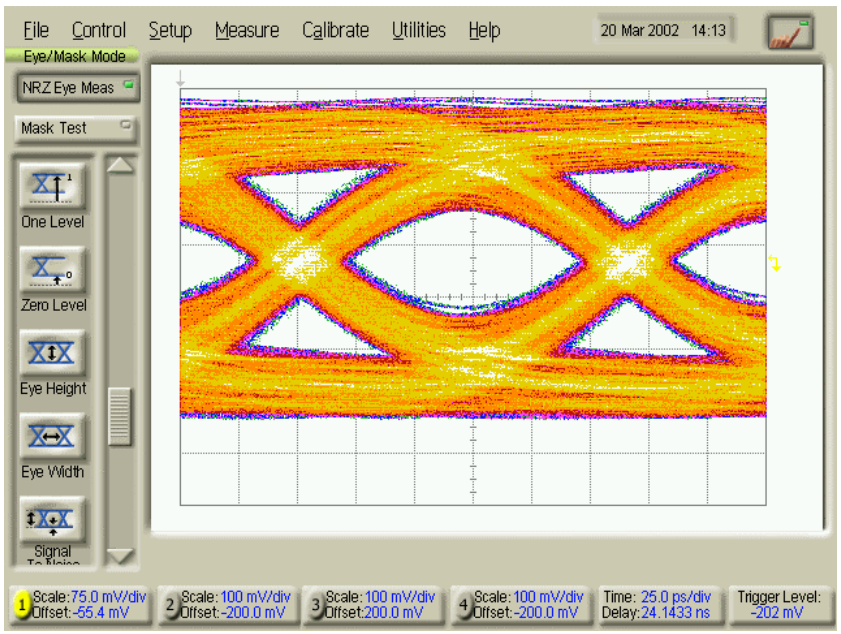
Eye Pattern Analysis



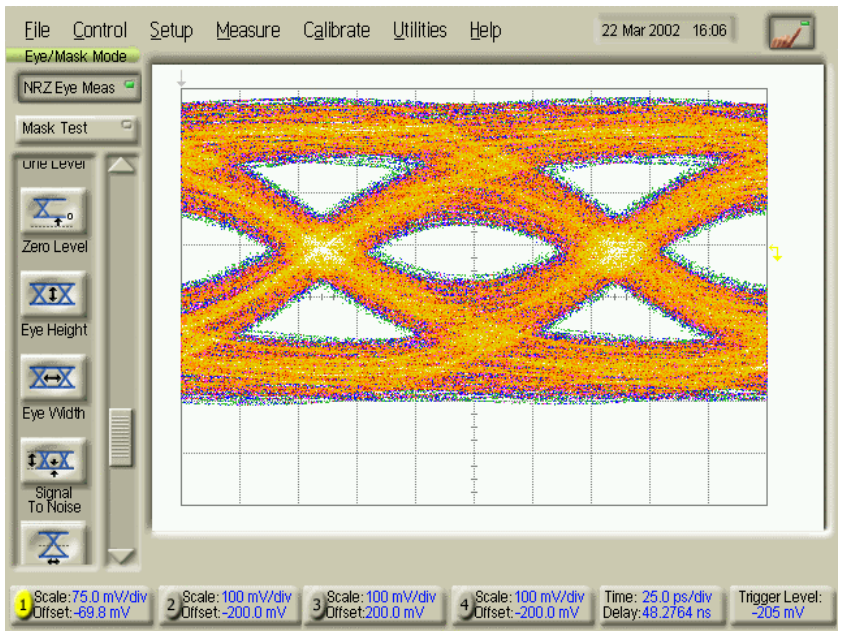
- Height of the central eye opening measures noise margin in the received signal
- Width of the signal band at the corner of the eye measures the jitter
- Thickness of the signal line at the top and bottom of the eye is proportional to noise and distortion in the receiver output
- Transitions between the top and bottom of the eye show the rise and fall times of the signal

Signal Integrity Measurements: 20 layer test vehicles: 10” at 7.5 Gb/s*

PTFE/glass fabric/BT-epoxy

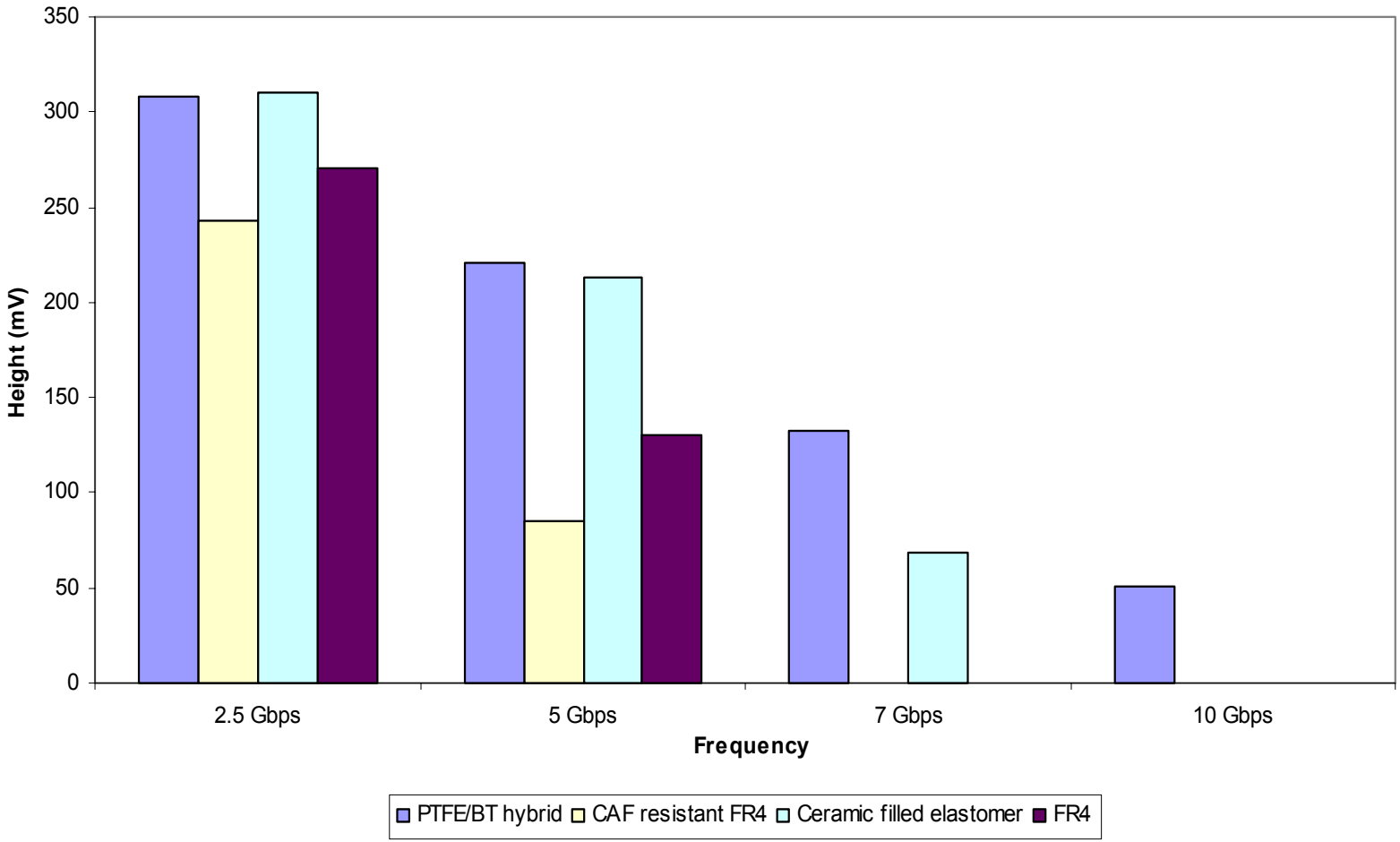


Ceramic filled elastomer

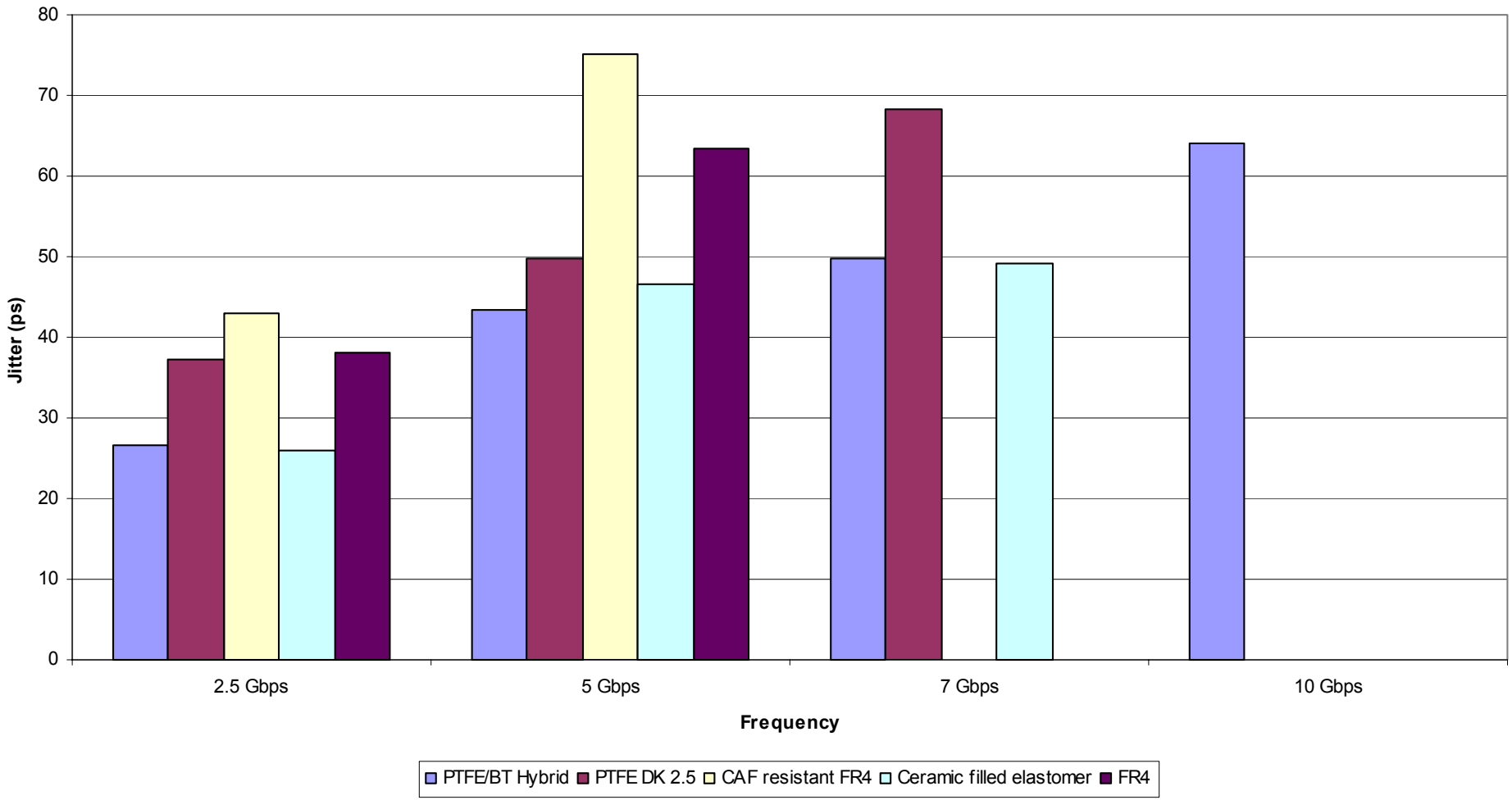


*Compliments of Teradyne Connection Systems

Eye Height
Material Comparison at 10”



Eye Jitter
Material Comparison at 10”



PTFE/Glass Fabric/BT-epoxy 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

Outlook for 10 Gb/s

Continued joint development work indicated high performance levels at 10 Gb/s.

At this point of time NDAs do not permit to show details yet.

Taconic Base Material Overview

	TLY (also: 605)	TLX / TLT (also: 601, 602)	TLE-95	TLC	RF-30	RF-35 / RF-35P	RF-60	CER-10
DK @ 10 GHz	2.17-2.33 (+/- 0.02)	2.40-2.60 (+/- 0.04)	2.95 (+/- 0.05)	2.70, 3.00, 3.20 (+/- 0.05)	3.0 (+/- 0.1)	3.50 (+/- 0.1)	6.15 (+/- 0.25)	10.0 (+/- 0.5)
Df @ 10 GHz	0.0009	0.0019 (TLT: 0.006 @ 1 MHz)	0.0028	0.0029	0.0014 (@ 1.9 GHz)	0.0025 (0.0018 @ 1.9 GHz) (RF-35P: 0.0033 @ 10 GHz)	0.0028	0.0035
Peel Strength (1 oz ED copper)	12 lbs/in	12 lbs/in	12 lbs/in	12 lbs/in	10-12 lbs/in	10 lbs/in	8 lbs/in	8 lbs/in
Moisture Absorption	< 0.02 %	< 0.02 %	< 0.02 %	< 0.02 %	< 0.02 %	< 0.02 %	< 0.02 %	0.02 %
CTE in Z axis (linear to ~ 350 °C)	280 ppm/°C	130-145 ppm/°C	70 ppm/°C	70 ppm/°C	125 ppm/°C	64 ppm/°C (RF-35P: 110)	75 ppm/°C	46 ppm/°C
CTE in X/Y axis	20 ppm / °C	9-12 ppm/°C	9-12 ppm/°C	9-12 ppm/°C	11-21 ppm/°C	19-24 ppm/°C	11-13 ppm/°C	13-15 ppm/°C
UL Rating TIR	V-0 105°C	V-0 105	V-0 105	V-0 105	V-0	V-0 105	V-0	V-0

Stand A5/543

TACONIC