PCB Technology Future Trend

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GOLD CIRCUIT ELECTRONICS

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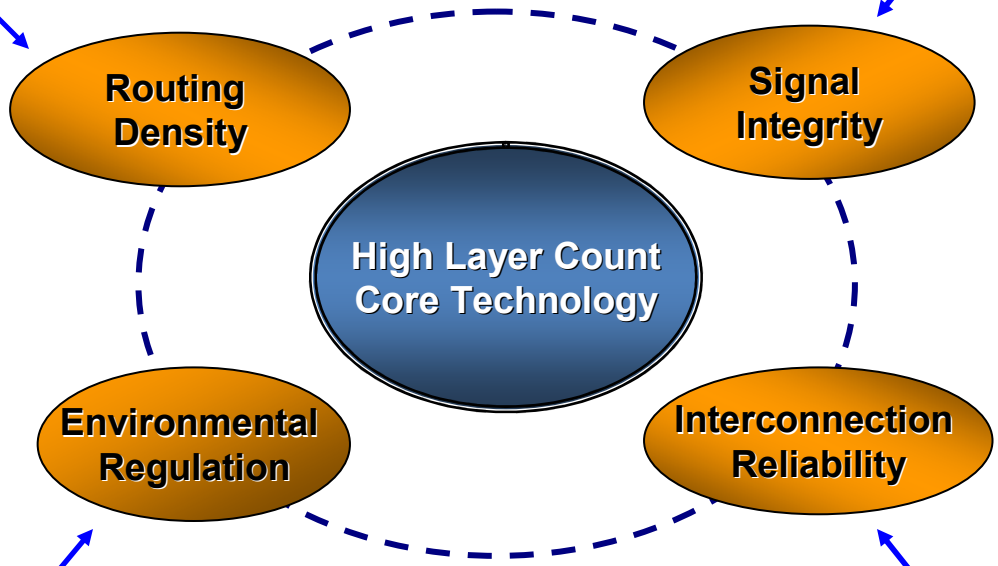
Agenda

- High Speed Channel Construction components
- Processor Road Map
- Supplier Status
- Material Availability Trend and Cost factor
- Dissipation Factor of different material
- Materials on Horizon
- Summary

Core Technology Trend for High Speed Channel Construction

1.Registration
2.Via In Pad
3.Reduction for Layer counts and Line/Space
4.HDI Micro/Skip/Buried via

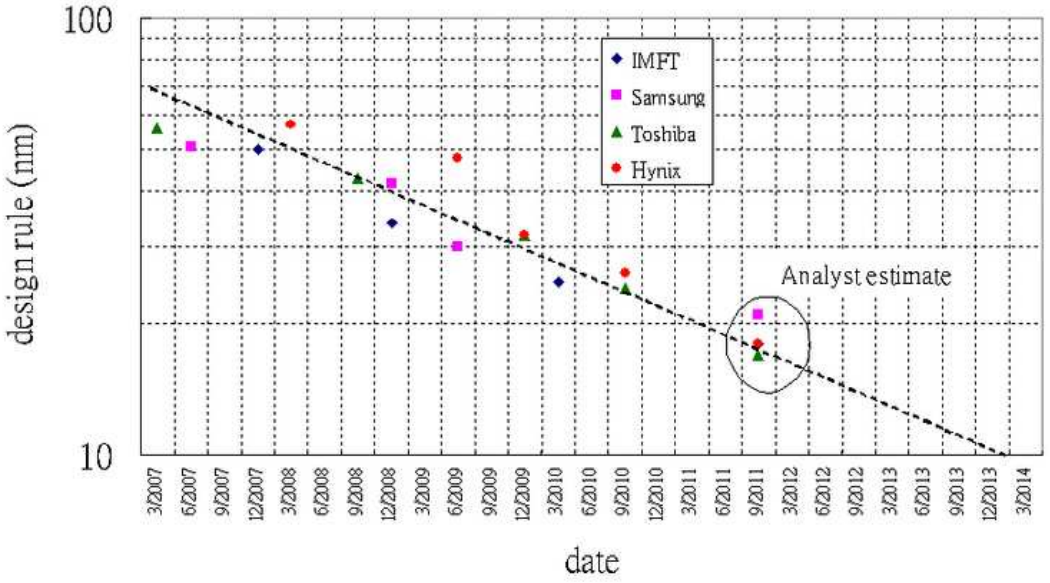
1.Back drill
2.Embedded Capacitor
3.Low Dk/Df materials
4.Insertion Loss control

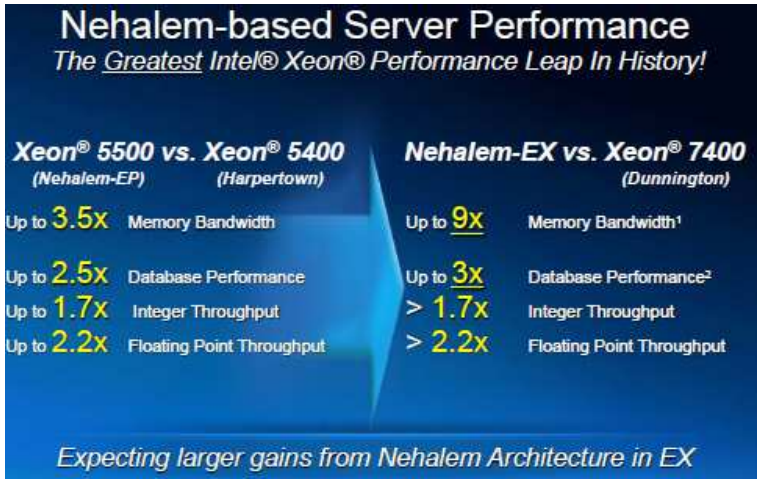


1.Lead Free materials
2.ROHS (Restricted of Hazardous Substances)
3.ISO …

1.CAF (Conductive Anodic Filament)
2.IST (interconnect Stress Testing)
3.ATC (Accelerated thermal cycle)
4.Thermal stress
5.CTE (Coefficient of thermal expansion)

Core Technology Trend

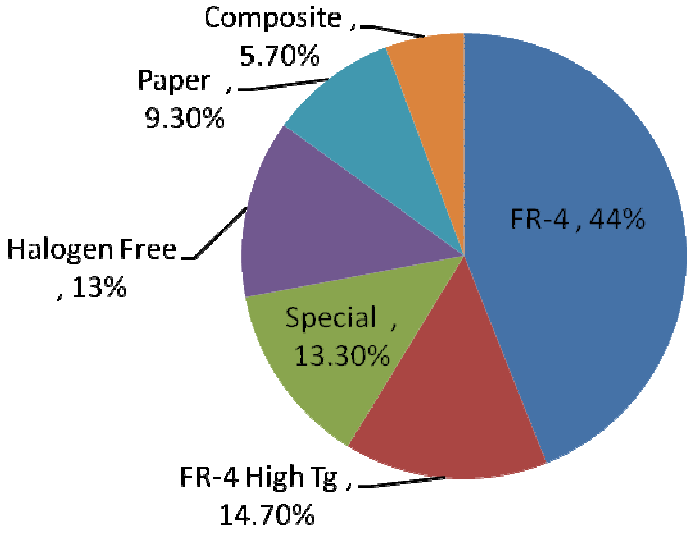




- **Moving and processing more data, more quickly will continue.**
- **"Getting by" with "mid loss" will go away in next 1-2 years.**
- **Low loss materials will become "mainstream", even "commodity" but not yet at this stage**

Supplier Status – Taiwan Perspective

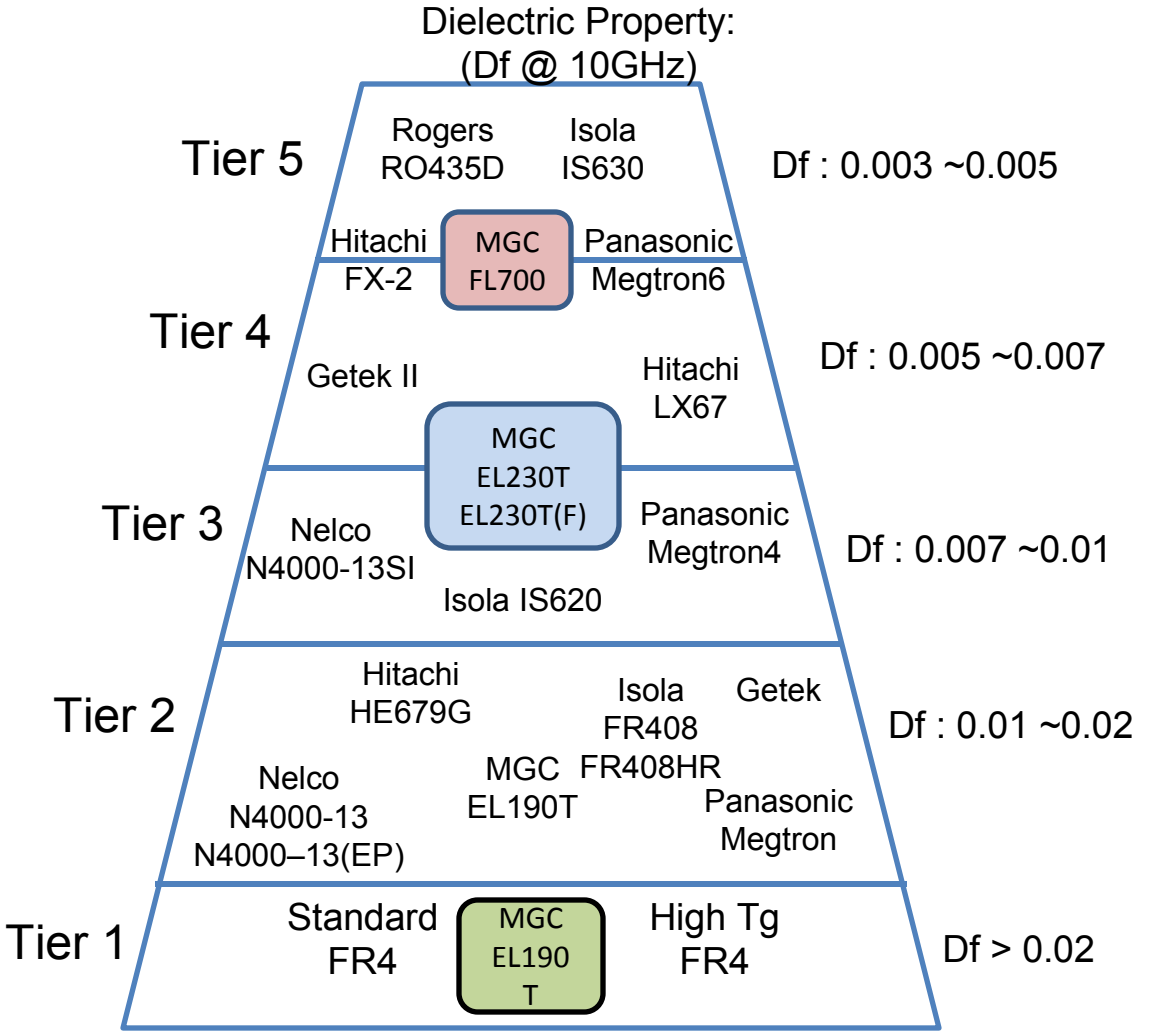
- Low + Ultra Low, less than 13% of total market.
- If there a big explosion in demand, cost will come down dramatically.
- Premium material suppliers will have a “Grip” on progress



Material	Estimated % of market based on market data
FR-4	44%
FR-4 High Tg	14.7%
Special	13.3%
Halogen Free	13%
Paper	9.3%
Composite	5.7%

Material Availability Trend

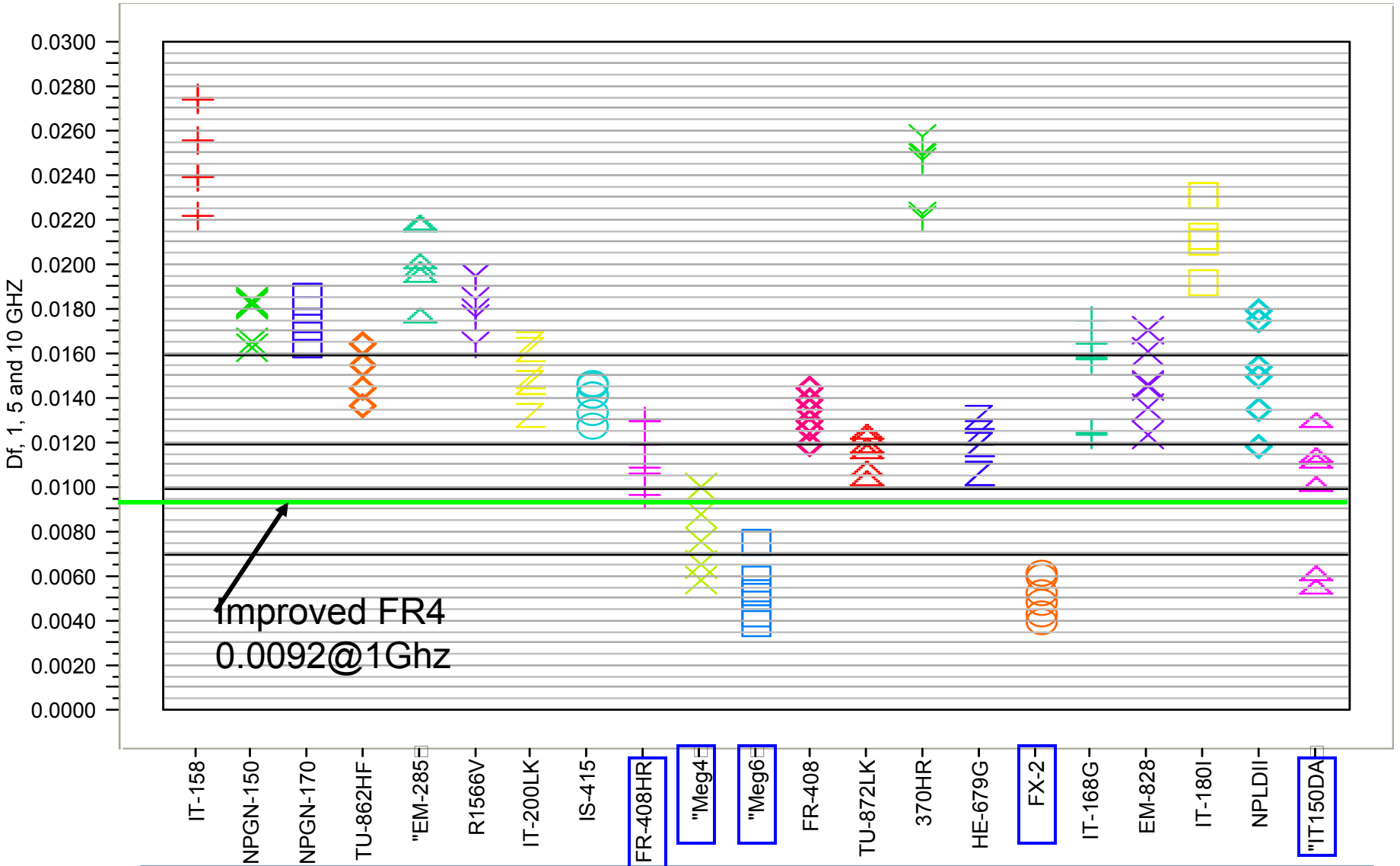
Common representation of performance vs cost in the market, but the pyramid is getting "flatter"



	Cost now	2013 (est)	2015 (est)
Tier 1	Std	Std	100%
Tier 2	100%	150%	
Tier 3	150%		
Tier 4	350%	200%	150%
Tier 5	450%	450%	300%
Tier 6	600%		

Note: "Improved FR-4" defined by 802.3ap is a Tier 2 material"

Status of Current Material Supply - Dissipation Factor at 1, 5, 10 GHz Stacked Chart

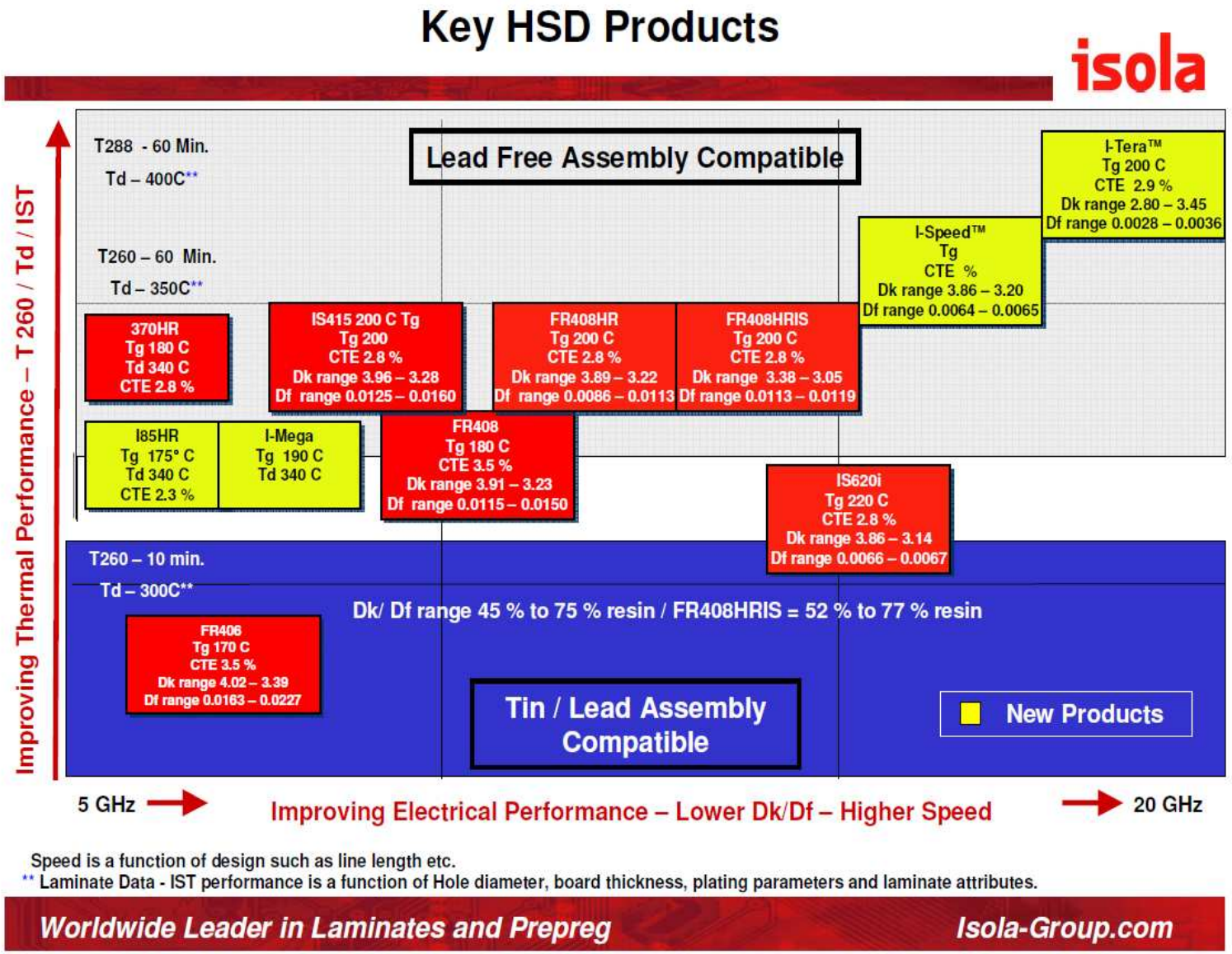


GCE Testing shows progress in “Low Loss Space” but finding that “Ultra Low Loss, low cost option (<0.007 Df at 10 GHz) is still evolving

Key New Low Loss Materials on Horizon

- Lower cost, Lower loss alternatives for material selection continue to evolve.
- I-Speed and I-Tera are new products form From Isola of interest
- IT-150D,IT-150DA, and IT-150DA SE/L from ITEQ
- MultiClad HF from Arion
- All aimed at Lower cost and to be Low Loss
- Regarding Halogen Free I168G and Multi-Clad (Arlon) are of interest
- Market need is beginning to offer solutions and this trend will continue as speed increases.

New Low Loss Materials: Isola



http://www.isola-group.com/products

New Low Loss Materials: ITEQ

		IT-150D	IT-150DA	IT-150DA SE/L	R-4X5X	MX-6
Products information		MTg very low loss	HTg very low loss	HTg very low loss	HTg Very low loss	HTg very low loss
Tg (□)	DSC (2.4.25)	165	180	180	280	185
T-288 (w/ 1 Oz Cu, min)	TMA (2.4.24.1)	30+	30+	30+	--	30+
Td-5%(□)	TGA 5% loss (2.3.40)	365	370	370	390	410
CTE (ppm/□)	a1/a2 (2.4.24)	45/260	45/250	45/250	35/--	45/--
CTE (%), 50-260□	TMA (2.4.24)	3.4	2.6	2.6	--	--
Peeling (lb/in)	1 oz (2.4.8)	6	6	6	5.0	4.6
Water absorption	D-24/23 (2.6.2.1)	0.1	0.1	0.1	0.04	0.18
Dk (HP4291B)	1 GHz (2.5.5.9)	3.6	3.6	3.3	--	--
Df (HP4291B)	1 GHz (2.5.5.9)	0.004	0.004	0.004	--	--
Dk (by frequency)	2-10GHz average	3.6	3.6	3.3	3.66	3.6
Df (by frequency)	2-10GHz average	0.005	0.005	0.004	0.0034	0.0032

IT150D series Dk/Df of 2-10GHz and average base on IPC TM650 2.5.5.13 resonance cavity method.
R-4X5X : Dk is based on full sheet resonance; Df is by IPC TM650 2.5.5.5 of 2.5-10GHz average.
MX6 : Dk/Df data by IPC TM650 2.5.5.5 of 2-10GHz average.
"—" : not available on data sheet.
Data of IT-150DA SE type will be formal published unit official datasheet approval.

http://www.iteq.com.tw/p4.asp

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New Low Loss Materials : Arlon Material

Important Product Properties:

Property	Units	Value
Dk / Df @ 10 GHz	--	3.7 / 0.0045
Tg (TMA)	°C	190
Decomposition Temp	°C (5%)	432
T300	Minutes	>60
CTE (X/Y)	ppm/°C	14-16
CTE(Z)	ppm/°C below Tg	20
	ppm/°C above Tg	150
Total Thermal Expansion	% (50 to 260°C)	1.2%
Copper Peel	lb/in (1 Ounce Foil)	8
Water Absorption	% (24 hour immersion)	0.15
Thermal Conductivity, Tc	W/m-K	0.64
Flammability	UL-94	Meets V0

MultiClad HF is designed for High-Speed Backplanes and Server boards, Power Amplifiers, Satellite receivers, LNB converters, as well as Semiconductor burn-in-boards and other high speed, high reliability applications.

http://www.arlon-med.com/MultiClad_HP_PressRelease.pdf

Summary

- 1M channel loss can be achieved by:
  - Low loss materials (FX2, I-Speed, I-Tera, IT-150D,IT-150DA,IT-150DA SE/L, MultiClad HF and Megtron-6)
  - Tweaking of materials and process
  - Smooth copper
  - Square weave glass
- 1M channel presented in Beukema_01_1111 and Kipp_01_1111.pdf
- More lower loss/lower cost material on Horizon
- Magtron 6 is **not the only option** for future low loss material
- “What if Intel requires low loss on next platform?”
- Demand will outpace supply.
- Current maturity 2011 is “not there” However, newer materials will achieve by 2013
- Short term “pain” will drive market solution

References

- Application of the Short-Pulse Propagation Technique for Broadband Characterization of PCB and Other Interconnect technologies

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- Iteq: http://www.iteq.com.tw/p4.asp

- Isola: http://www.isola-group.com/products/