



INEMI[®]

International Electronics Manufacturing Initiative

HFR-Free (Halogen Flame Retardant) Technology Leadership Project

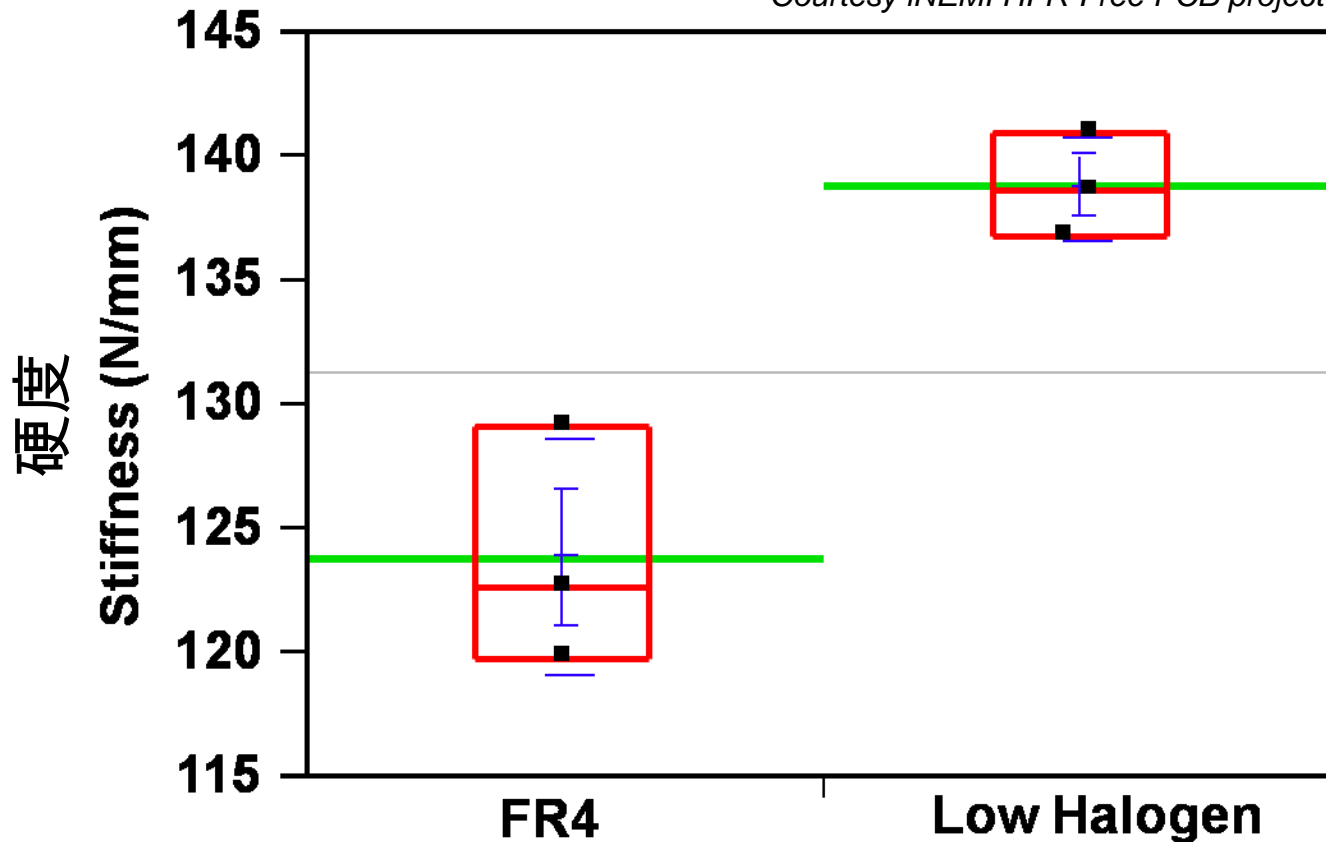
Advancing manufacturing technology

Agenda

- **Technical Concerns**
- **Supply Chain Impact**
- **Consortium Objectives**

Solder Joint Reliability (SJR, 焊接可靠性)

Courtesy iNEMI HFR-Free PCB project



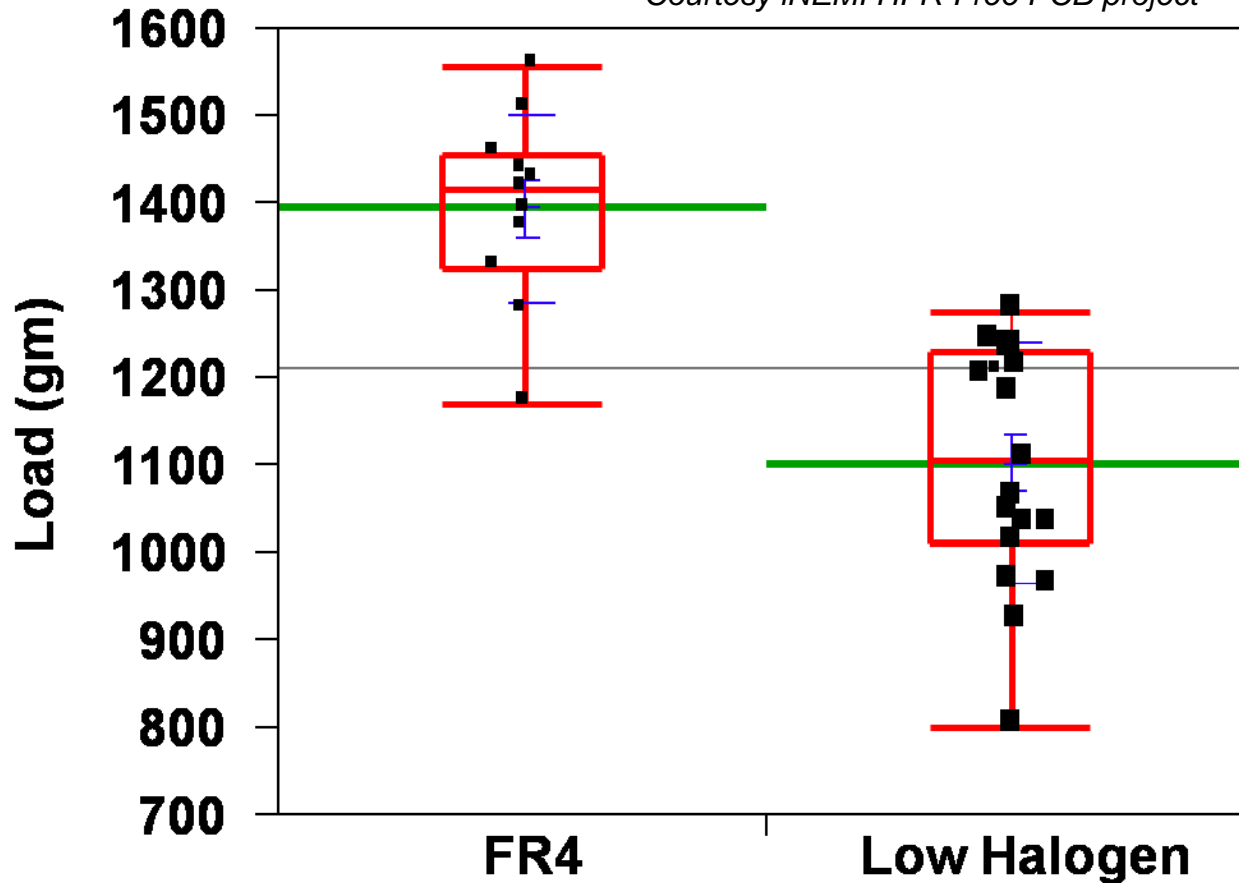
HF is ~10% stiffer
(8 layer .062" board)



Lower mech stress limits
(higher SJR risk)

Pad Crater Performance 焊盘剥落特性

Courtesy iNEMI HFR-Free PCB project



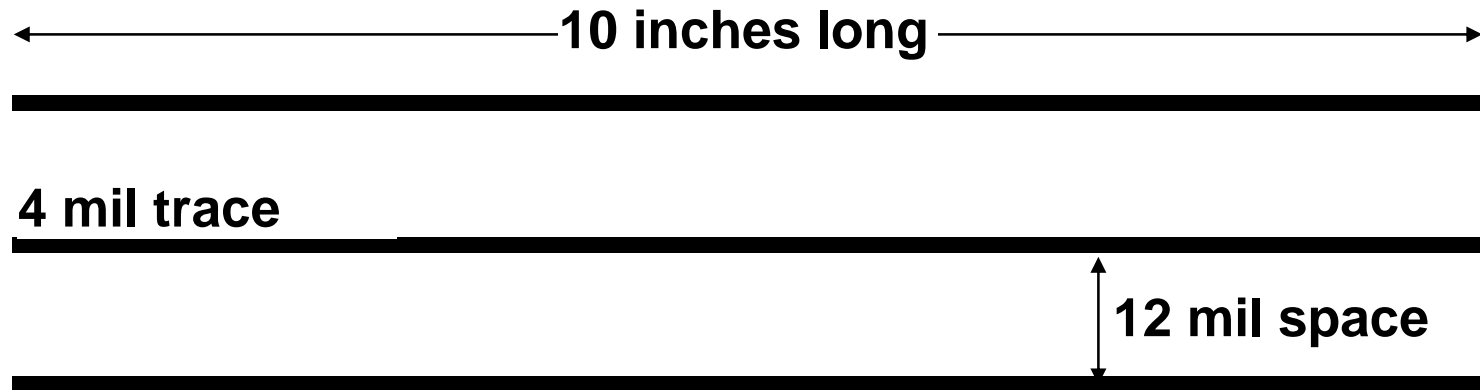
HF has ~20% worse cold ball pull performance



Increase pad cratering
(higher rework risk)

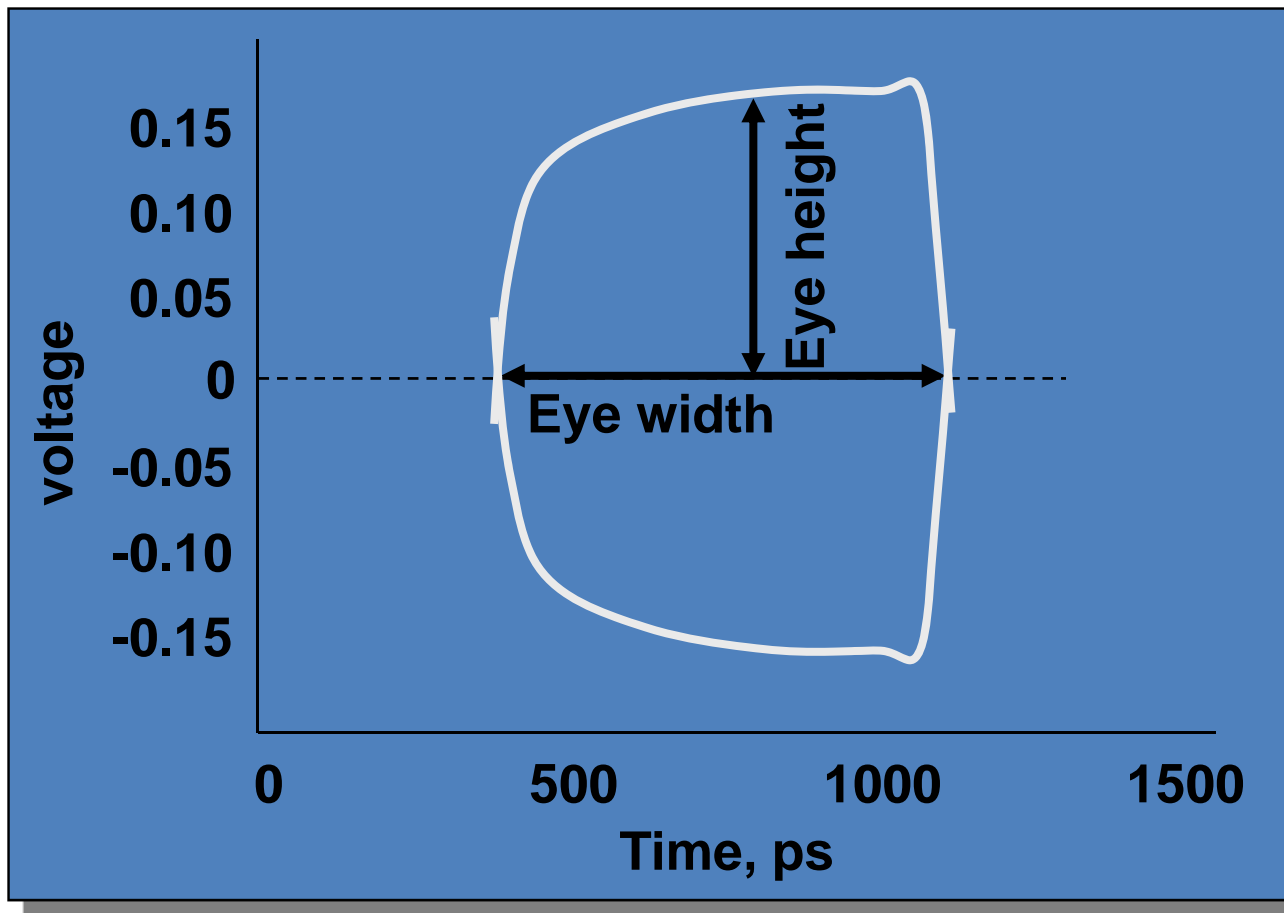
Some parameters will have less margin!

High Speed Signaling 高速信号



- **Simulation Conditions 模拟条件**
 - 3 single ended traces
 - Constant impedance (50Ω)
 - No discontinuities (no vias, no connectors)

High Speed Signaling 高速信号



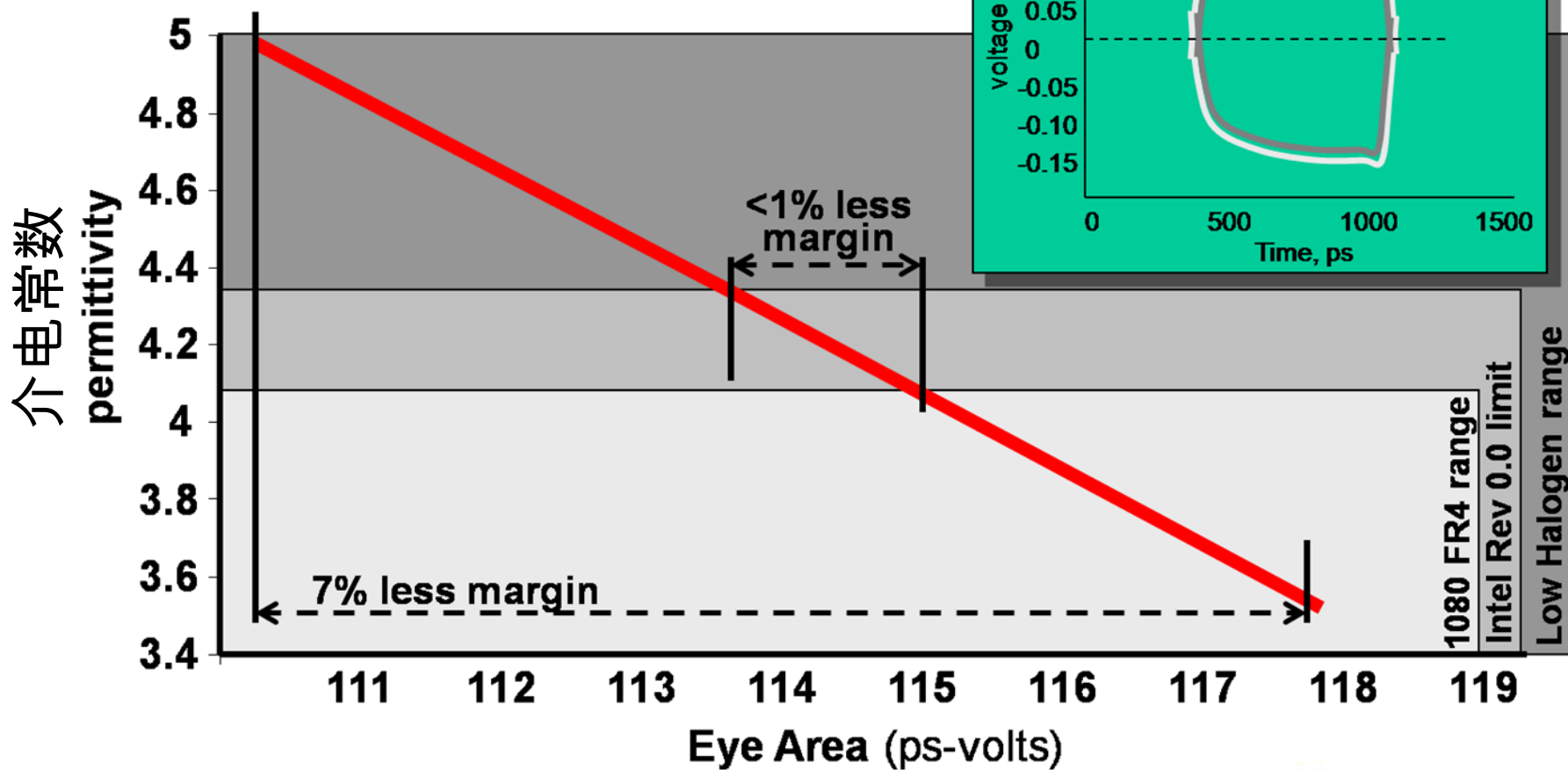
Eye Area = eye width x eye height

解释：眼图面积的大小表明有用信号和干扰及漂移的相对强弱

Technical Concerns

High Speed Signaling

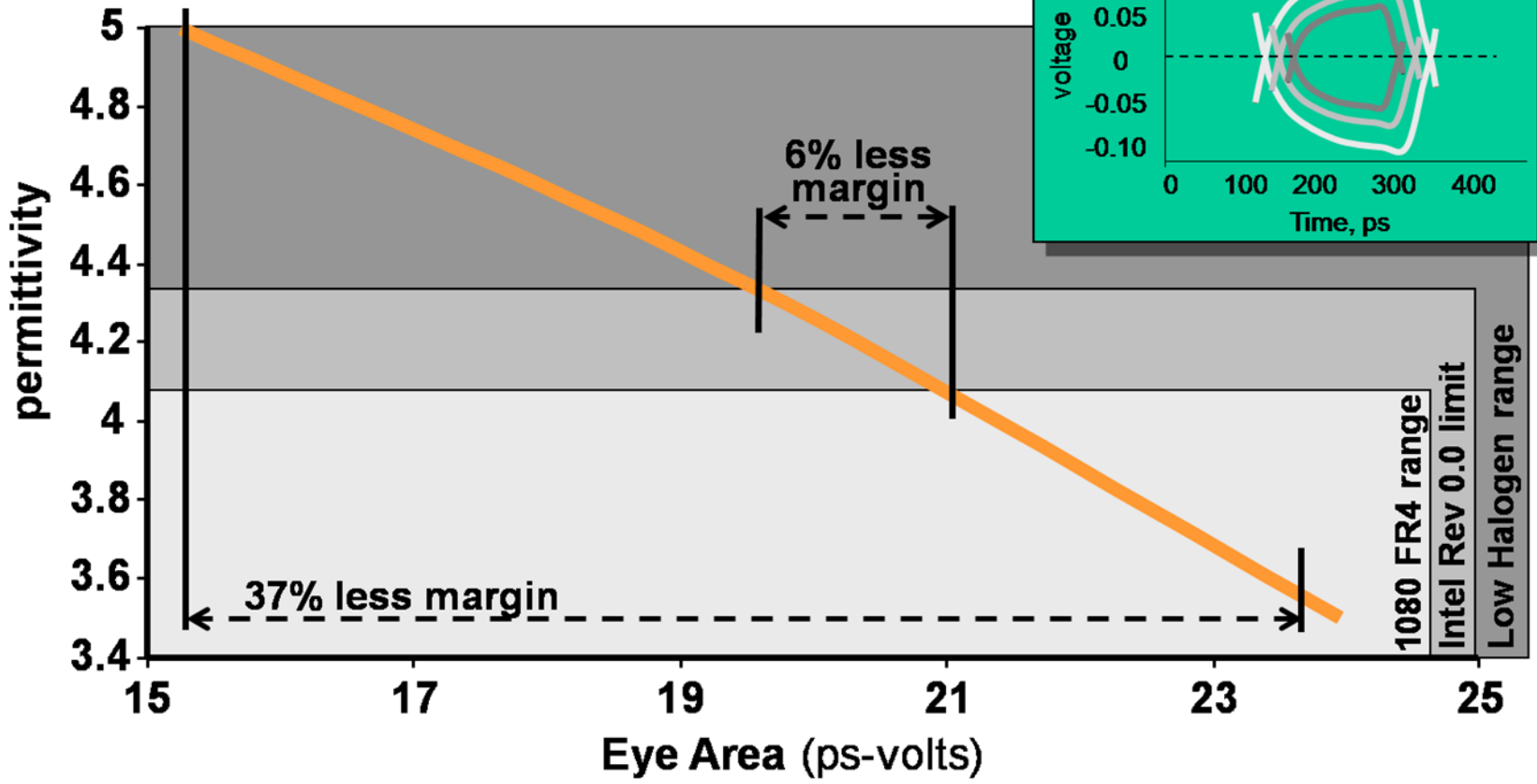
0.667Gbit/sec (DDR2) data rates



Technical Concerns

High Speed Signaling

2Gbit/sec (DDR3) data rates

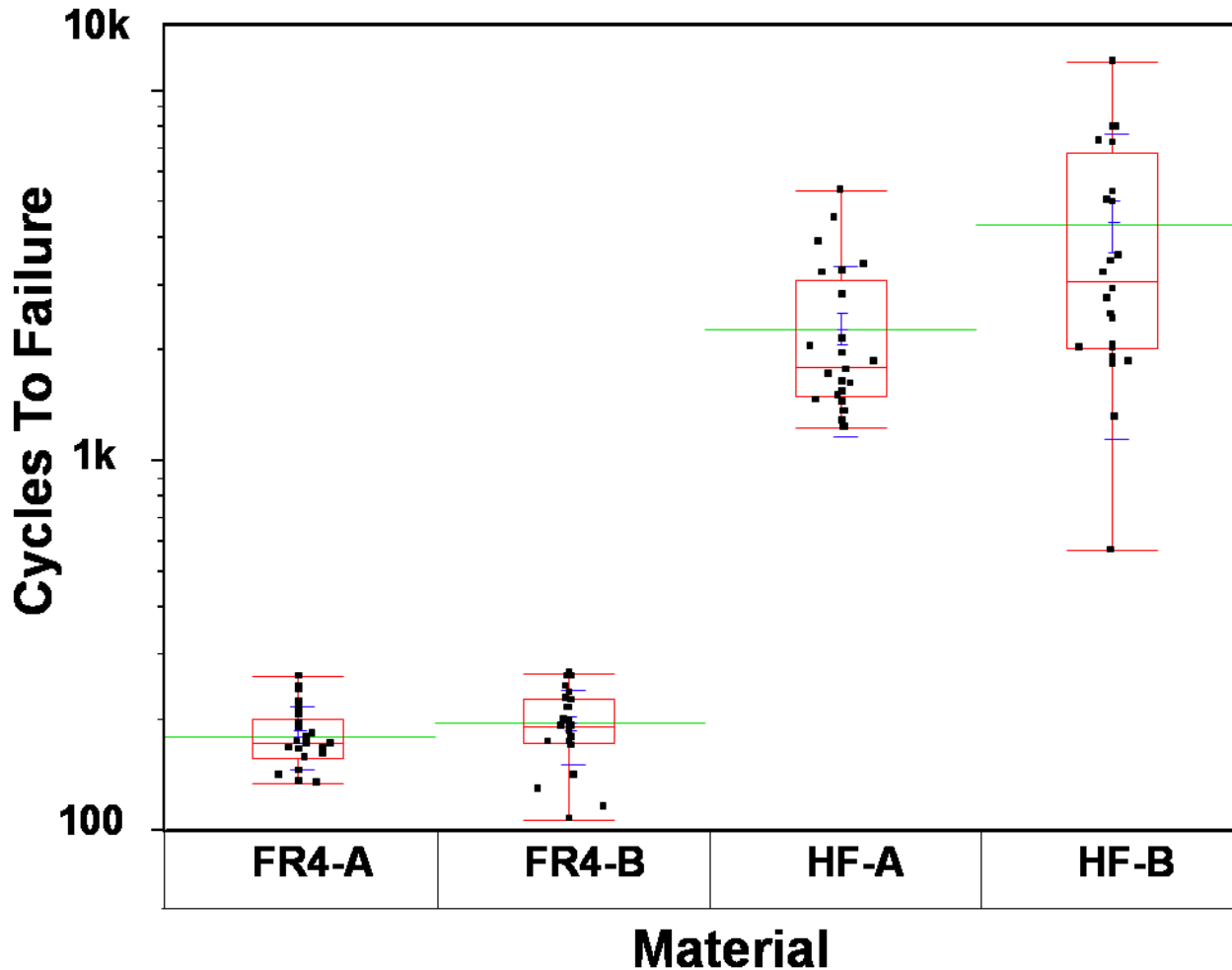


Emerging buses are more sensitive!

新的总线要求更敏感



Good News: Via Reliability 孔的可靠性



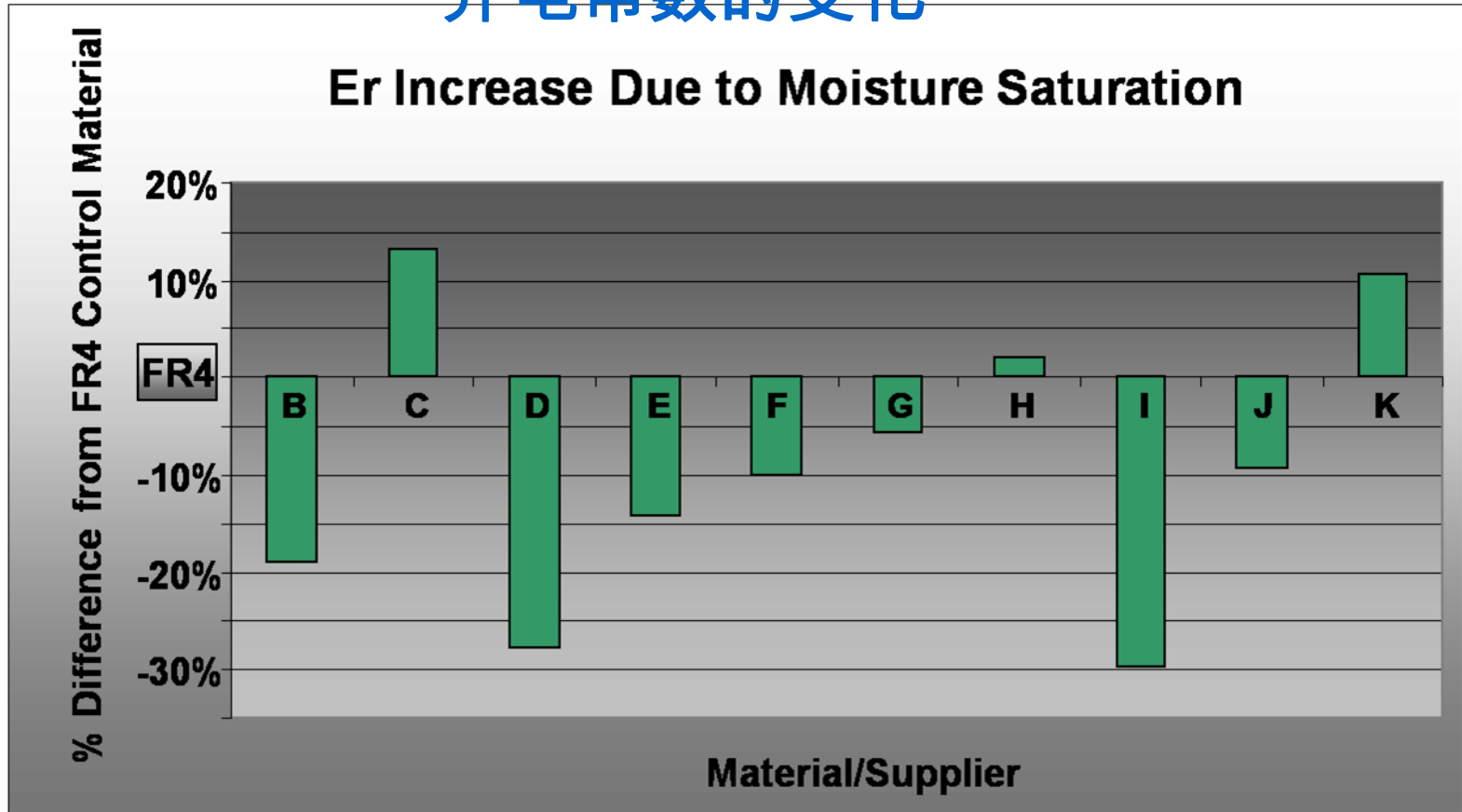
HF materials have 10X better via reliability
(using IST testing)
(冷热循环互连应力测试)

- Preconditioned: 3X (260°C peak reflow temp)
- 3 minute heat up cycle
- Temp: 25°C – 150°C
- 1.5 minute cool down



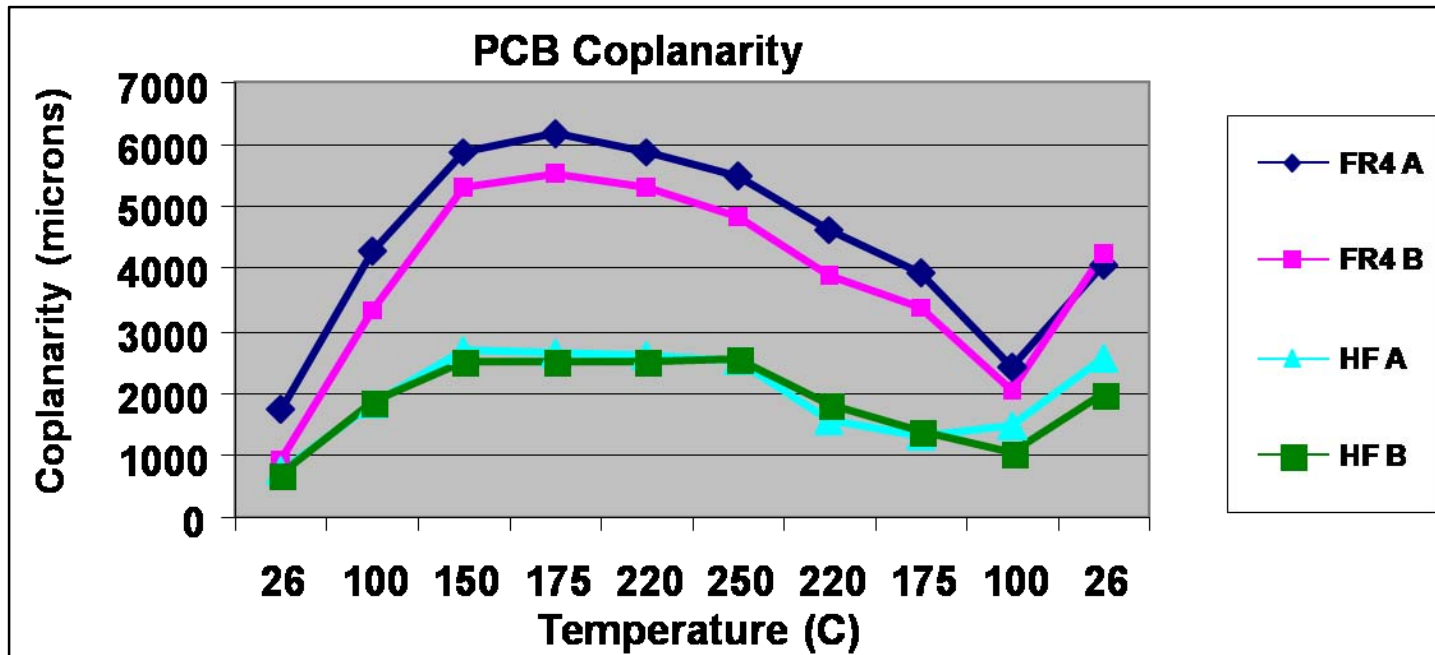
Good News: Dielectric Constant Variability

介电常数的变化



Less Er variation due to moisture for most halogen-free laminates

Good News: Warpage 热变形



HF exhibits ~50% less warpage

(vs. Hi Tg FR4, 8 and 10 layer)



Sags less during reflow

(better solder joint control, reduced need for pallets)

Material Selection Summary 材料选择小结

Mat'l	Dk	Df	H ₂ O Absorb	Tg	CTE	Flex	Td	T260/ Cu	T288/ Cu	Peel Strength	IST	CAF	UL94 V0	Shock	Vibe	Temp Cycle	Cold Ball Pull
A	Red	Green	Yellow	Yellow	Green	Red					Green	Green	Green	Red	Red	Red	Red
B	Red	Green	Yellow	Yellow	Green	Red	Green	Green	Yellow	Green	Green	Green	Green	White	White	White	Red
C	Green	Green	Yellow	Yellow	Green	Red	Green	Green	Green	Green	Green	Green	Green	Red	White	White	Red
D	Green	Green	Yellow	Yellow	Green	Red	Green	Green	Green	Green	Green	Green	Green	White	White	White	Red
E	Green	Green	Yellow	Yellow	Green	Red	Green	Green	Yellow	Yellow	Green	Green	Green	White	White	White	Red
F	Red	Green	Yellow	Yellow	Green	Red	Green	Green	Yellow	Green	Green	Green	Green	White	White	White	Red
G	Yellow	Green	Yellow	Yellow	Green	Red	Green	Green	Yellow	Green	Green	Green	Green	Red	Red	Red	Red
H	Yellow	Green	Yellow	Yellow	Green	Red	Green	Green	Yellow	Yellow	Green	Green	Green	White	White	White	Red
I	Yellow	Green	Yellow	Yellow	Green	Red	Green	Green	Green	Green	Green	Green	Green	White	White	White	Red
J	Yellow	Green	Yellow	Yellow	Green	Red	Green	Green	Yellow	Green	Green	Green	Green	White	White	White	Red
K	Green	Green	Yellow	Yellow	Green	Red	Green	Green	Green	Green	Green	Green	Green	White	White	White	Red

Color Code

- Equal to or better than FR4 (No issue)
- Marginal vs FR4 (Issue not clear)
- Worse than FR4 (Clear Issue)
- No Data

Derived from iNEMI WG data

Material selection can matter!



Growth Projections 增长的预测

MARKET AND GROWTH OF RIGID LAMINATE

Standard FR4

Area (Mm ²)	2006	2007	2012	Value CAAGR ('07-'12)
FR 4 Total	256.8	284.4	430.3	8.6%
Notebook		18.0	39.1	16.7%
Desktop		35.3	40.4	2.7%
Mobile Phone		14.7	21.6	8.0%
Other (Server, consumer)		216.4	329.2	8.8%

HFR-free

Area (Mm ²)	2006	2007	2012	Value CAAGR ('07-'12)
HFR-free FR 4 Total	11.4	20.9	60.9	23.9%
Notebook		3.9	13.8	29.0%
Desktop		1.8	5.2	23.6%
Mobile Phone		7.5	21.4	23.4%
Other (Server, consumer)		7.7	20.5	21.6%

CAAGR: Compound aggregate annual growth rate
年复合增长率



If HFR-free supplants halogenated FR4, CAAGR grows to almost 70%
(assuming HF FR4 reaches FR4 volumes in '12)



Consortium Objectives 联盟目标

- 1. Identify technology readiness, supply chain capability, and reliability characteristics for “BFR-free” alternatives to conventional printed circuit board materials and assemblies**
查看技术是否就绪，产业链的能力以及无溴化阻燃剂替代品在常规PCB材料和装配中的可靠性能
 - Spans electrical and mechanical properties 包括电和机械属性
 - Includes assessing if board/system design modifications can overcome material property limitations 评估板/系统设计的修改是否能弥补材料属性的限制
- 2. Define technology limits for BFR-free materials across all market segments** 定义各产品门类对无BFR材料的技术性能的限制要求
 - Initial focus is on client platforms (desktop, notebook)
 - Goal is to drive laminate supplier slash sheet content

Summary

- **A broad transition to halogen-free materials could become quite disruptive 大范围地转为无卤材料可能有破坏性的影响**
- **Existing halogen-free materials are worse than existing brominated FR4 on several key parameters 就几个关键参数而言，目前的无卤材料较溴化FR4差**
- **This effort is focused on driving tradeoffs across design, fabrication, and materials to derive solutions 该项目的重点是要使设计、生产和材料相互折衷互补来解决问题**