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Testing the Lead Free Compatibility of Circuit Board Materials

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Background

- "High Frequency Materials: Setting the Pace for Lead free Processing" published in trade journal in May 2006
  - Article discussed lead free compatibility of filled hydrocarbon resin product family
  - Described aggressive regimen of "functional" tests

Materials Tested

- Functional tests applied to materials from four suppliers:
  - FR4-Type Cores/Prepregs: 155C, 165C, 175C, 180C, 190C, 210C, 225C
  - Filled Hydrocarbon Cores/Prepregs: HC/HCP, HCFR/HCP
  - Filled PTFE: FT/FT, FT/HCP
  - Lightly Filled, Reinforced PTFE: FGT/Preg

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Properties Considered

- Functional tests considered four areas of concern to laminate suppliers:
  - **Thermal Properties**
    - **Data sheet properties**
  - Cu Bond Retention
    - Multiple thermal exposures
  - Cu Bond @ Rework Temperatures
    - Reliability of adhesion @ temperature
  - PTH Reliability
    - Through extreme shock & fatigue conditioning

Thermal Properties

- Key Thermal Properties:
  - Glass Transition Temperature (Tg)
    - DSC, TMA*, DMA*
  - Decomposition Temperature (Td)
    - 5% Weight Loss
  - Coefficient of Thermal Expansions (CTE)
    - Varied Temperature Ranges
  - Time to Delaminate (T-###)
    - T-288

*MLB's Tested

Significance of Glass Transitions

- Significance of Tg Clouded?
  - Glass Transition Temperature (Tg):
    - Transition of resin system from rigid, glass-like form toward softer, rubbery state
      - DSC
        - » Changed Heat Flow Characteristics
      - TMA
        - » Changed Thermal Expansion Rates
      - DMA
        - » Changed Mechanical Characteristics

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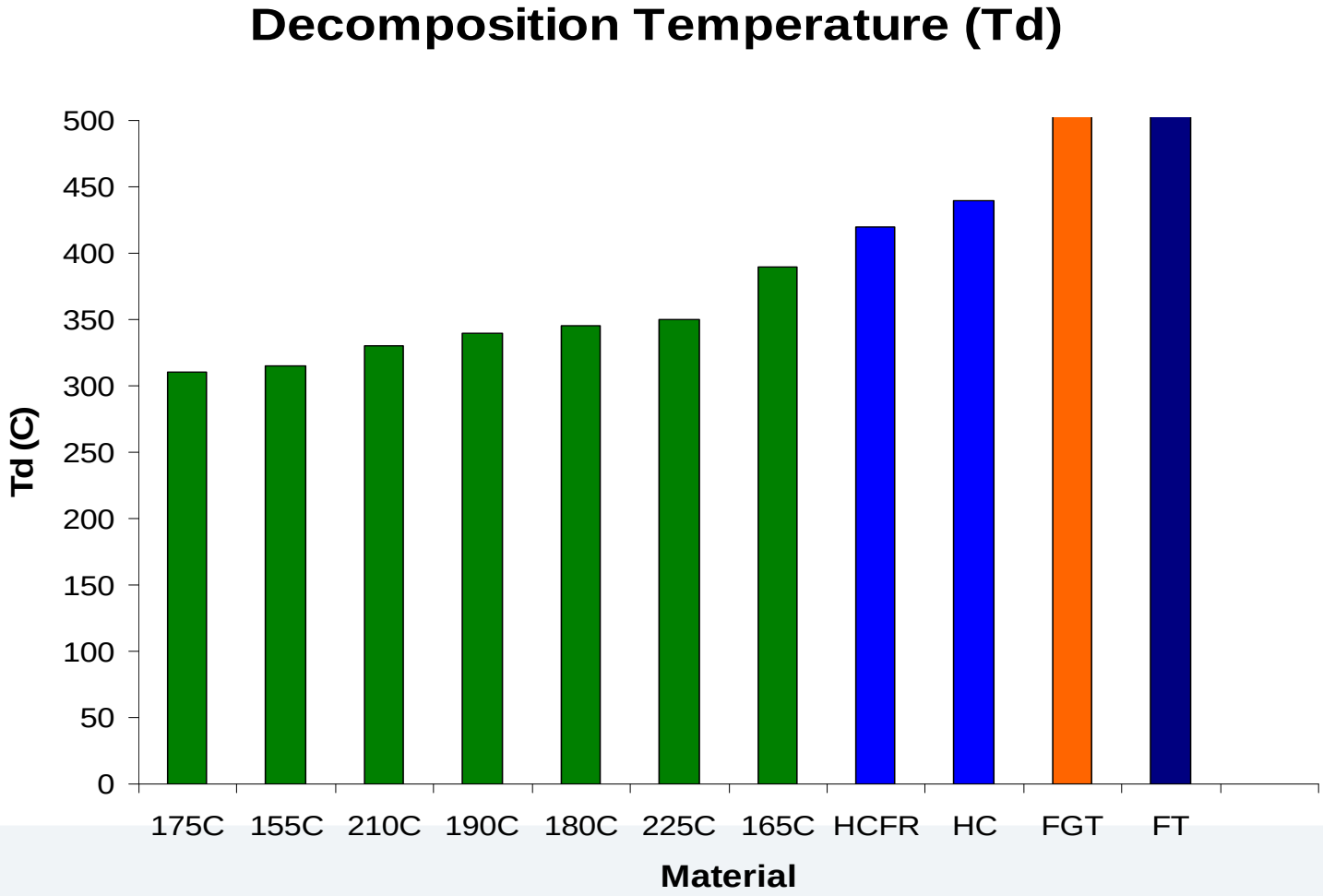
        - » Changed Mechanical Characteristics
- Question magnitude of change

Measured Glass Transitions

Material	DSC (C)	TMA* (C)	DMA* (C)
FT (N/A)	29	28	31
FGT (N/A)	32	30, 175	30, 175
HCFR (280C)	No	No	94
HCF (280C)	No	No	97
190C	155	176	151, 213
155C	160	150	158
175C	160	162	160
180C	176	175	173
210C	175	171	176, 227
165C	175	175	179
225C	198	219	195, 224

*Tested on MLB's

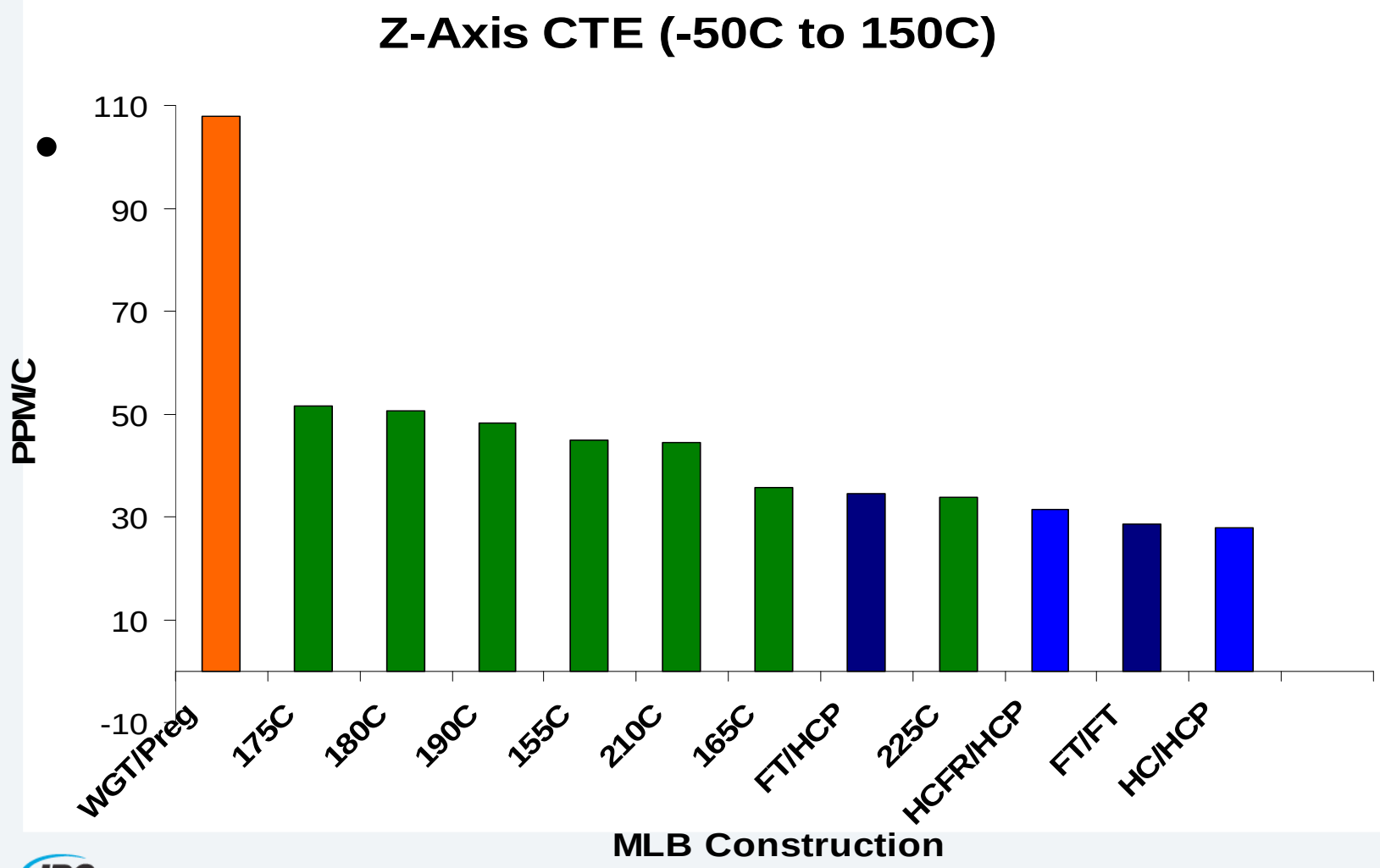
Decomposition Temperature (5% Wt Loss)



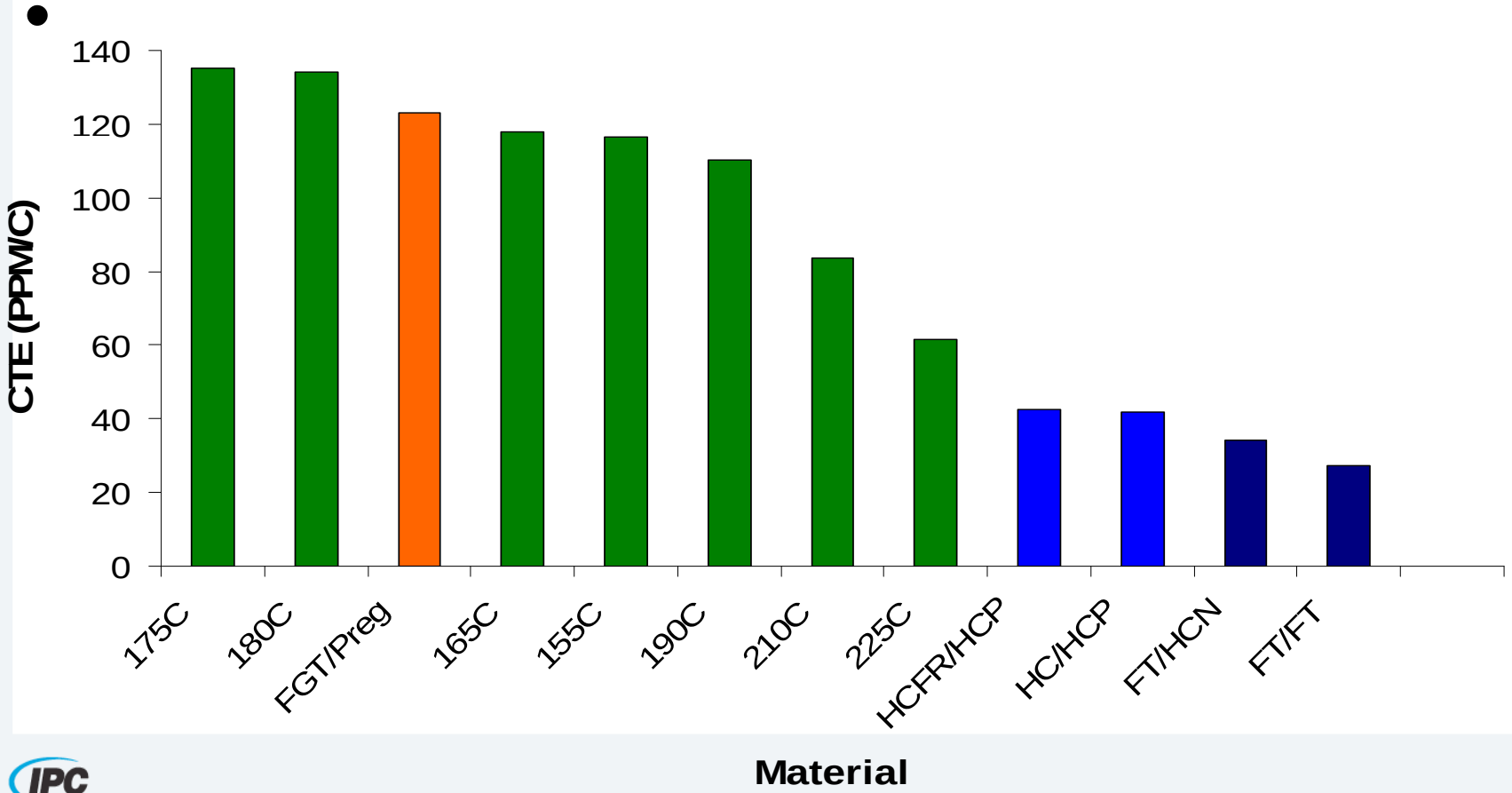
Z-Axis CTE of MLB's

- Calculated:
  - -50C to 150C
  - 0C to 250C
  - 50C increments –50C to 250C

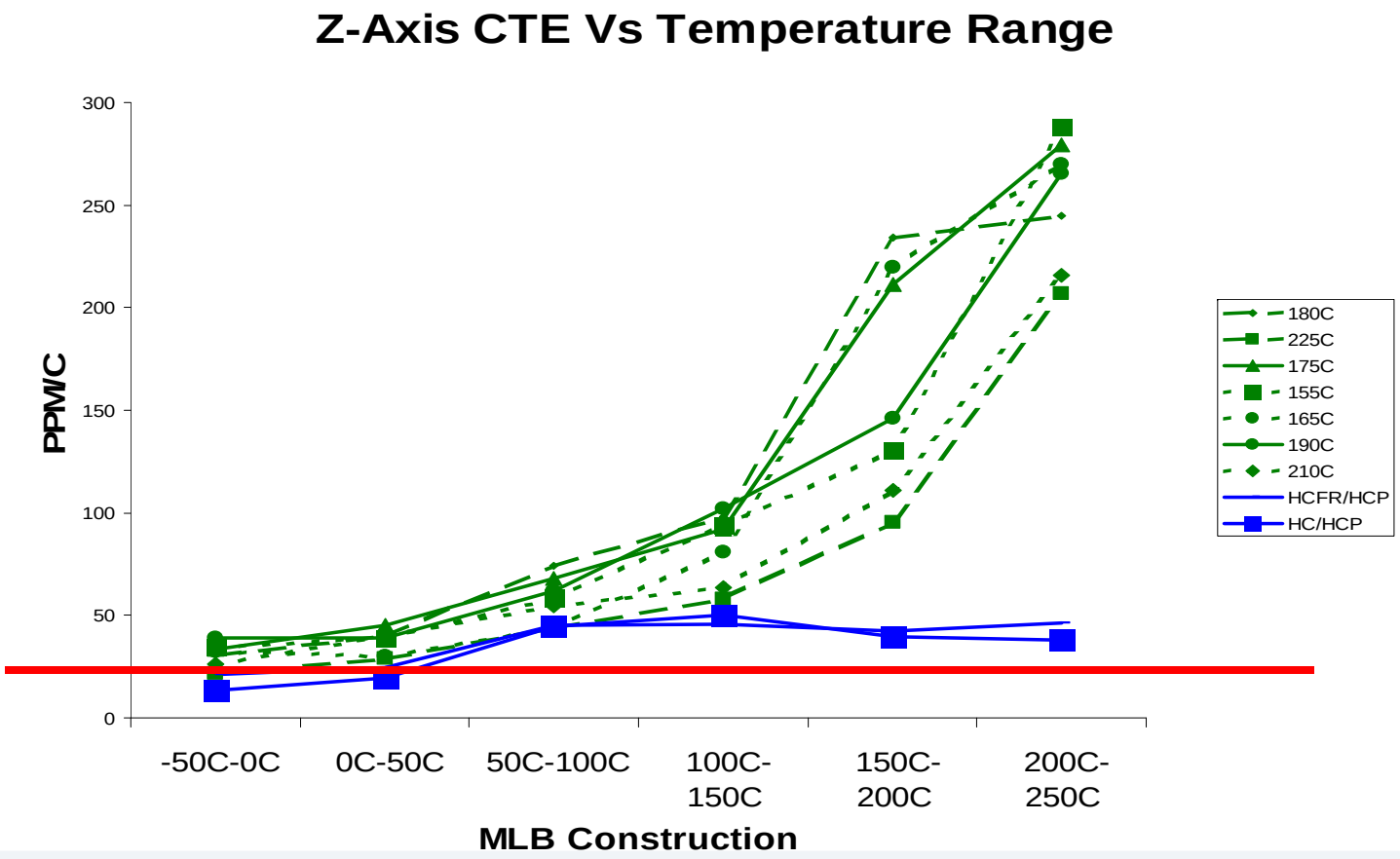
-50C to 150C Z-Axis CTE



0C-250C Z-Axis CTE



Z-Axis CTE @ 50C Increments



Z-Axis CTE @ 50C Increments