



P A R K
E L E C T R O C H E M I C A L
C O R P .



Nelco Products, Inc.

- Welcomes IPC Designers Council – Orange County Chapter!



Agenda

- Base Material Basics
- Base Material Components/Applications
- Circuit Designs and Concerns
- Key Properties of Base Materials
- Impact of Trends in PCB Design
- Laminate/Prepreg Mfg Overview
- Industry Services
- Questions/Wrap Up



Base Material Basics

- Various Types of Base Materials
- Classified by:
 - ✓ Electrical Properties
 - ✓ Physical Properties
 - ✓ Mechanical Properties
 - ✓ RoHS Compliance – Lead Free Reflow 260C
 - ✓ REACH Compliance
 - ✓ Flammability Rating



Base Material Basics

➤ Identification

- ✓ IPC-4101 – Specification for Base Materials for Rigid and Multilayer Printed Boards
 - Examples – /24, /26, /29, to name a few.
- ✓ IPC-4103 – RF Designs
 - Electrical tolerancing ranges – dielectric constant, loss requirements
- ✓ NEMA Industrial Laminating Thermosetting Products
 - Examples – FR4, G-10, CEM-1, to name a few.
- ✓ MIL-S-13949 – cancelled Mil Spec; replaced by IPC-4101.



Base Material Basics

➤ Laminate Identification Scheme

✓ Example: L 25 1500 C1/C1 A A

- Material Designator – “L” = laminate.
- Spec Number Sheet – “25” from IPC-4101.
- Nominal Laminate Thickness
- Metal Cladding Type and Nominal Weight/ Thickness – “C1/C1” = Electrodeposited Copper, (IPC-4562, grade 1), 1 oz. Cu both sides.
- Thickness Tolerance Class – A/K, B/L, C/M, D.
- Surface Quality Class – A, B, C, D, X.



Base Material Basics

➤ Prepreg Identification Scheme

✓ Example: P 25 E7628 TW RE VC

- Material Designator – “P” = prepreg.
- Spec Number Sheet – “25” from IPC-4101.
- Reinforcement Style – “E” = E-glass; 7628 = glass fabric style.
- Resin Content Method – “TW” = treated weight; other options “RC” = % resin content; 00 = not specified.
- Flow Parameter Method – “RE” = rheological flow.
- Optional Prepreg Method – “VC” = volatile content.



Base Material Components

- Base Material Components
 - ✓ Resin System, including Additives
 - ✓ Reinforcement
 - ✓ Conductor
- Infinite Combinations!



Base Material Components/Applications

➤ Resin System

- ✓ Epoxy Resin Systems – most common.
 - Good mechanical, electrical, and physical properties.
 - Di-, Tetra-, and Multi-Functional
 - Relatively low cost compared to higher-performance resins.
 - Baseline for most PCB processing
 - True insulating material – not as good at heat dissipation.



Base Material Components/Applications

➤ Other Resin Systems

- ✓ Epoxy Blends – for higher Tgs.
- ✓ Phenolic – many switching to this material; no different processing.
- ✓ Bismaleimide Triazine (BT)/Epoxy – used in chip packages; mechanical properties approximate those of chips.
- ✓ Cyanate Ester – higher Tg than epoxy; easier to process than polyimide; tremendous electrical properties. Radomes, some lower-end antenna applications. Low dielectric constant.



Base Material Components/Applications

➤ Other Resin Systems

- ✓ Polyimide – high Tg; originated from military for field repairability; toughness. Used in Down-Hole applications; oil industry.
- ✓ Polytetrafluoroethylene (PTFE, teflon) – high frequency applications; low dielectric constants, extreme low loss is imperative. Most long-range antenna and amplifiers applications.



Base Material Components

➤ Additives

- ✓ Curing Agents and Accelerators – organic
 - Reacted together to promote polymerization and cross linking
 - Amine-based curing agents are common – “dicy.”
- ✓ Flame Retardants
 - Bromine – halogenated
 - Halogen-Free – phosphorus, inorganic, nitrogen.
- ✓ UV Blockers/Fluorescing Aids



Base Material Components

➤ Reinforcements

✓ Woven Fiberglass

- E-Glass – >50 % Silicon Dioxide; most common.
 - 4-5 dielectric constant
- S-Glass – higher ratio of Silicon Dioxide.
 - Dk of 4
- Cloths – common 106, 1080, 2113, 2116, 7628.
- Warp (Grain) – machine direction.
- Fill – non-machine direction.
- Plain weave

✓ Other Reinforcements – paper, non-woven glass, kevlar.



Base Material Components

➤ Conductive Material

- ✓ Foil Grades – IPC-4562.
 - 1 – 11, electrodeposited, annealed, as rolled-wrought, etc.
- ✓ Electrodeposited (ED) Foil most common
 - Electrochemical process
- ✓ Bonding Treatments
- ✓ Passivation and Antioxidants Coatings



Base Material Components

➤ Conductive Material

- ✓ Drum Side Treated Foil (DSTF) or Reverse Treated Foil (RTS)
 - Electrodeposited Foil
 - Treatments are coated onto smooth drum side
 - Very Low Profile – matte “treated” side facing out.
 - Fine features, better electrical performance at high frequencies.
- ✓ Double-Treated Copper Foil



Circuit Designs and Concerns

- Circuit Designs – two general types.
 - ✓ Analog, RF, Microwave
 - ✓ Digital
- What is Power Budget?
- Material Choices – properties.



Key Properties of Base Materials

- CTE under Tg
- Arc Resistance – for thin cores (2 to 3 mils); perform Hipot test.
- All Materials Meet or Exceed IPC-4101/4103
 - ✓ Copper Peel Strength
 - ✓ Flammability with Bromine or Phosphorus
- Dielectric Constant/Permittivity
- Dissipation Factor/Loss Tangent
- Water and Moisture Absorption
- Decomposition Temperature Td



Impact of Trends in PCB Design/HDI

- Demands for
 - ✓ Circuit densification
 - ✓ Higher circuit operating frequencies
- Further Consideration for Material Performance
- Circuit Densification – three ways.
 - ✓ Decrease line width and spacing
 - ✓ Increase number of layers
 - ✓ Reduce via and pad sizes



Impact of Trends in PCB Design/HDI

➤ Laminate Constructions

- ✓ Single-Ply vs. Multi-Ply Constructions
- ✓ Resin Contents
- ✓ Laminate Flatness and Flexural Strength

➤ Prepreg Options

- ✓ Similar to Laminate Constructions
- ✓ Sufficient Resin Flow and Fill Capability



Impact of Trends in PCB Design/HDI

- Dimensional Stability
- High-Density Interconnect (HDI)
- CAF Growth
- Electrical Performance Demands



Impact of Trends in PCB Design/HDI

➤ Copper Foil

- ✓ High Temperature Elongation (HTE)
- ✓ Low Profile and RTF
- ✓ Thinner Foils
- ✓ For High Performance Resin Systems
 - Copper Roughness and Attenuation



Prepreg and Laminate Manufacturing

➤ Prepreg Manufacturing

- ✓ Cloth Unwind
- ✓ Treat with Epoxy Resin
- ✓ Partially Cure – tower; forced air convection.
- ✓ Perform In-Process Tests
- ✓ Cloth Wind
- ✓ Cut Prepreg to Length – B-Stage
 - Lam Grade – further advanced.
 - Prepreg Grade



Prepreg and Laminate Manufacturing

➤ Laminate Manufacturing

- ✓ Cut Copper to Length
- ✓ Layup Lam Grade Prepreg and Copper
- ✓ Press or Laminate
- ✓ Send for Testing
- ✓ Trim
- ✓ Cut Laminate to Size
- ✓ Inspect/Ship



Industry Services

- Design for Manufacturing (DFM) Input
 - ✓ Input from PCB Fabricators/Material Supplier
 - ✓ Welcome opportunity to be part of DFM review up front
- Collaborate with PCB Designers
- Key Engineering/Design Personnel
- For Cutting Edge PCB Designs
 - ✓ **Proactively** Identify Technical Issues
 - ✓ Recommend Solutions



Industry Services

- Customer Process Reviews
- Perform Detailed Process Review at PCB Fab
 - ✓ Material Issue through Copper Plating
 - ✓ Perform Independent Review of Processes
 - ✓ Identify Possible Areas of Concern
- Provide Final Report – Review in Detail



Questions/Wrap Up

- Questions?
- Any Other Items to be Covered?
- Feedback?
- Wrap Up

