ALTIUMLIVE 2018:  
FLEX: SOMETHING NEW FOR EVERYONE

Tara Dunn  
Omni PCB  
President  
San Diego  
October 5, 2018
Applications That Span Technology
Today’s Discussion:

1. Basic processing steps for both subtractive etch and semi-additive flexible circuit manufacturing

2. Flex materials and considerations

3. Design for manufacturability best practices

4. Real world lessons learned
Basic Process Steps – PCB Fabrication

Key differences between subtractive etch and SAP:
- Base materials
- Develop -Etch -Strip process
- Hole Metalization
Basic Inner Layer Process Steps – Subtractive Etch

INNERLAYER FABRICATION
PRINT AND EXPOSE

DEVELOP

Copper Clad Laminate
Photo-tool
Photo-resist
Copper foil
Dielectric

Copper foil
Photoresist
Dielectric
Basic Inner Layer Process Steps – Subtractive Etch

ETCH

Artwork features are plotted larger than finished lines for etch compensation.

STRIP

Dry film resist is removed.
Basic Inner Layer Process Steps – Semi – Additive Processing

1. Start with polyimide film
2. Coat polyimide with ALD Ink
3. Plate with thin electroless copper
4. Apply and pattern resist
5. Electroplate traces
6. Strip resist and remove thin electroless copper
Basic Process Steps – Semi – Additive Processing

• 35 µm pitch, 24 µm lines, semi additive

25 µm traces, polymide with gold conductors, semi additive
Base Material Types and Considerations

Base Materials: Two Primary Construction Types

- Adhesiveless Flex Core
  - 1 Ounce Copper
  - Adhesiveless Polyimide Flex 1 Mil
  - 1 Ounce Copper

- Flex Core with Adhesive
  - 1 Ounce Copper
  - Acrylic Adhesive
  - Adhesiveless Polyimide Flex 1 Mil
  - Acrylic Adhesive
  - 1 Ounce Copper
How Do You Select Base Materials?

1. Layer Count
2. Flex or Rigid Flex
3. Cost
4. SAP
Coverlay Options and Considerations

Cost vs. Function

Solder mask on flex circuit

Coverlayer on flex circuit

Liquid polyimide
Stiffener Options and Considerations

**Stiffener Types**

- Maintain .030” overlap between stiffener and coverlay to avoid adding stress points
- FR4 adds component support
- Polyimide stiffeners
Rigid Flex

Key Points:

• Adhesiveless Materials

• Bikini Cut the coverlay (.050” into the rigid areas)

• PTH should be .050” from edge of flex / rigid interface

• Cost Considerations
Design for Manufacturability Tips: Universal across manufacturing types

Key: Communicate operational requirements to your fabricator, especially with dynamically flexing applications
**Design Tips**

### Design for Manufacturability Tips

- **Single Metal Layer**: 3-6 times material thickness
- **Two Metal Layers**: 7-10 times material thickness
- **Multilayer Flex**: 15-20 times material thickness
- **Dynamic Flexing**: 20-40 times material thickness.

*Thru holes should be placed at least .050” away from any bend areas.*

---

*Preferred practice is to route conductors perpendicular to bend and fold areas in a single metal layer if possible.*

- **Preferred Routing**
- **Not Recommended**

- **Bending Zone**
- **Staggered Construction Preferred**
- **I-Beam Construction Not Preferred**

---

*BEND RADIUS*

*CIRCUIT THICKNESS*
Design Tips

Tips and Tricks for increased flexibility

- Remove Material
- Route traces to second side and remove copper in flexing area
- Cross hatch copper
- Un-bonded layers
- Consider Button-Plating to eliminate ED copper on panel when creating the PTH
Case Study Medical Pill Camera: Rigid-Flex 4 Layer PCB

Very small part .5” by 1” in size on 15-up array. The part is ingested in pill form.

- **PROBLEM:**
  - Customer had soldering issues on Micro BGA
  - High volume offshore solution needed 100K+ pieces annually

- **SOLUTION:**
  - Offered via fill solution
  - Implemented copper filled vias in 4 mil holes for Micro BGA pads
  - After solution was implemented the customer had zero rejects
  - Qualified off shore partner for high volume production
  - Shipped over 100K parts
Case Study Avionics Application: Rigid-Flex 4 Layer PCB with 2 stiffeners

PROBLEM:
- Customer had 70% failure rate from existing supplier
- Copper in Flex area was cracking due to flex area of PCB being bent several times

SOLUTION:
- Redesigned stack-up
- Converted customer to adhesiveless kapton material
- Decreased Flex Circuit thickness from 19.6 mils to 13.4 mils a 32% decrease
- Extra thickness was adding rigidity to flex area and causing copper to crack once circuit was bent to form application
- Part is populated, bent to shape and shipped to customer.
- Now qualified on a 12 year program with customer
Real World Lesson Learned

Materials and Metal System for Neural Probes

- A single metal system and reliable materials proved to be the best for this and other implanted probe applications
- The overall simplicity leads to fewer manufacturing steps and greater yield and reliability

- Neural probes for brain stimulation
- Unique gold on polyimide without any tie layer -- ideal for In Situ applications
- 25 μm leads
- 64 leads per side
- NYU / Duke / Univ. of PA research consortium
Real World Lesson Learned

Case Study: Integrating Subtractive Etch Layers with SAP Layers

PROBLEM:
- High density routing requires every layer via design
- Ten layer design requires 4 lamination cycles, which is both expensive and has an extended lead time

SOLUTION:
- Convert 4 of the 10 layers to SAP with 1 mil line and space
- Reduce the total number of layers needed to 8
- Integrate the SAP layers with 4 layers of subtractive etch processing
- Reduce the lamination cycles required from 1 to 4
- In development now with future development planned with LIP-C processing
Thank you!