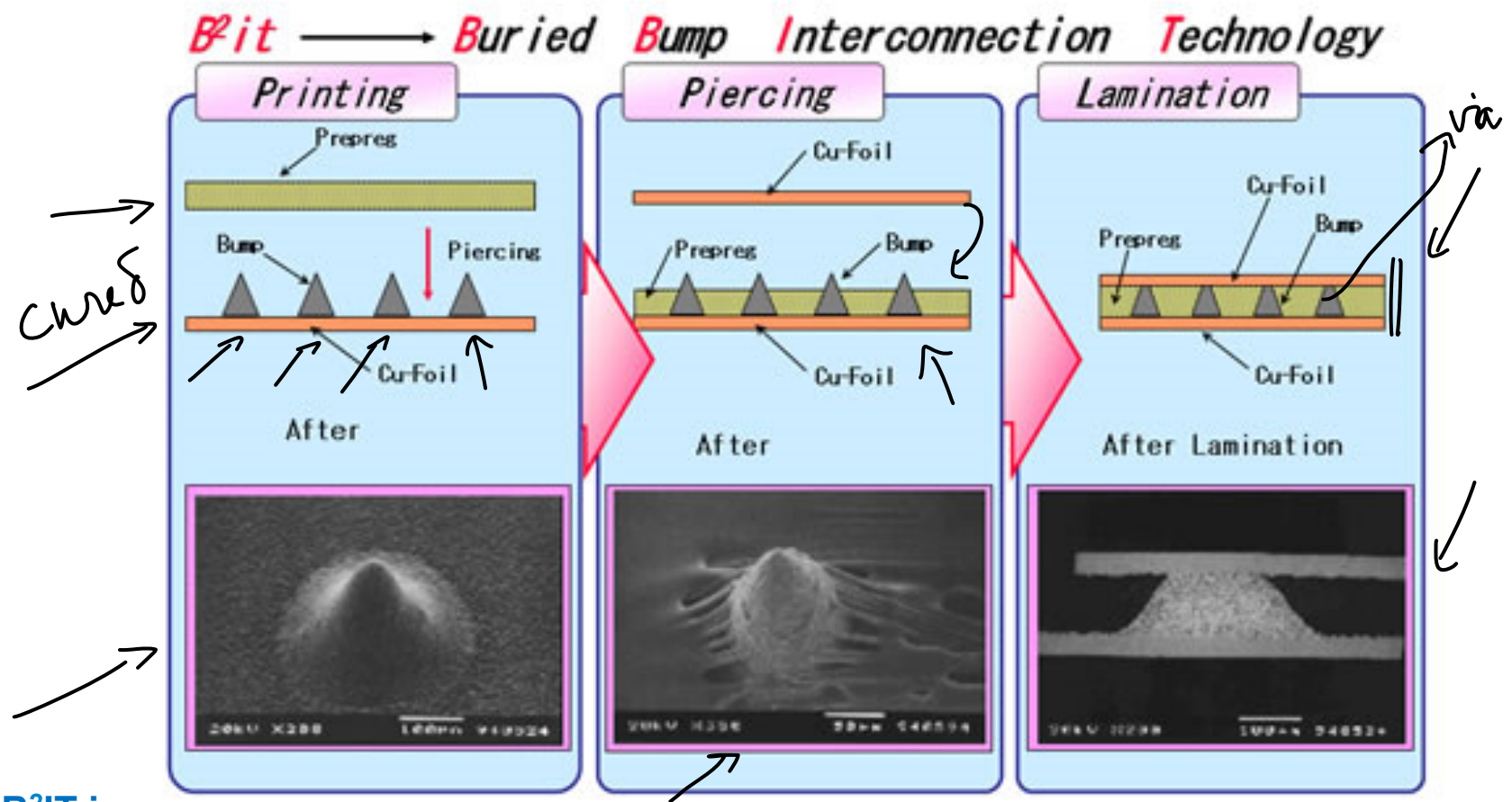
Continuing..

PRINTED WIRING BOARD TECHNOLOGIES

B²it Basic Process

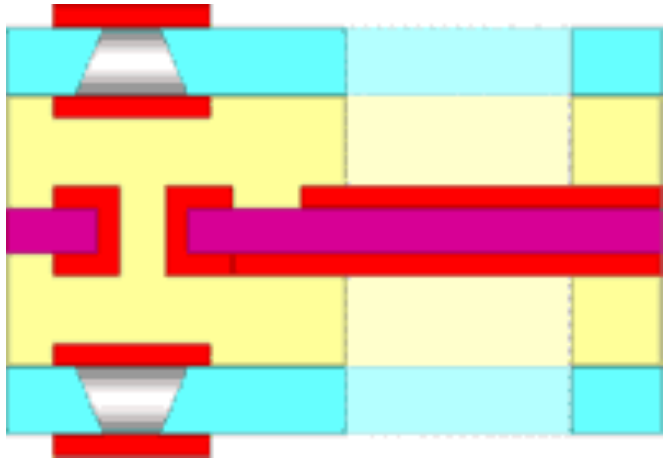


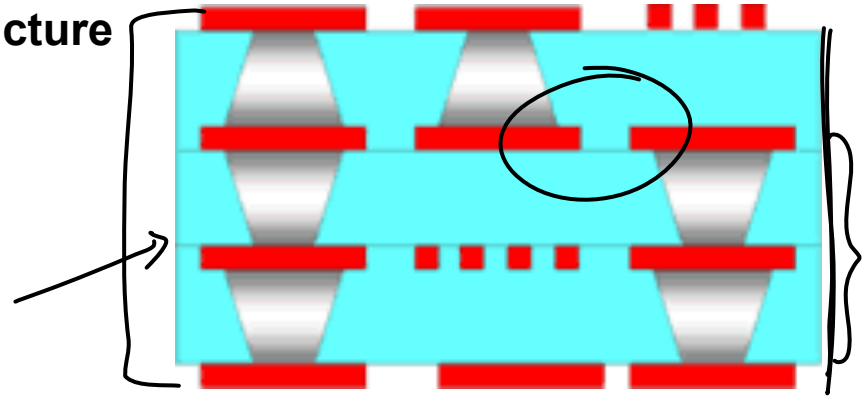
B²IT is a Toshiba Process Technology

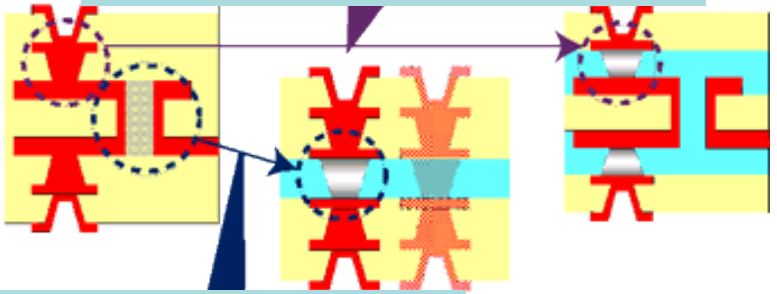
1. Conductive Ag bumps are printed on a sheet of Cu foil.
2. Prepreg is pierced through by the bumps
3. Another sheet of Cu is also laminated and a two sided B²IT board is manufactured.

Merits of B²IT

1. **Simple Process**
2. **Wide Choices of Insulation** → electrical performance
3. **All Layers Stacked Via Random Via structure**
4. **Combination with other HDI (High Density Interconnection) Technologies**
5. **Various Types of Multi Layer structure**







B²IT is a Toshiba Process Technology

CONVENTIONAL MLB

DESIGN, FABRICATION, TEST, MATERIALS, THERMAL & ECONOMIC ISSUES

- Use of prepreg for stacking of layers
- Very useful for power plane design
- Power electronics boards-ideal
- Not a parallel process-drilling bottleneck (mechanical)
- Aspect ratio ideal between 2 and 4
- Established reliability of through-holes
- Registration of stack/holes requires more tolerance in design
- Registration errors costly- boards are discarded
- Add-up layers need to be symmetric around the core; equal weight distribution of copper foils during press.
- Use of copper foils a must for stacking
- Repair and rework of inner layers difficult
- Minimum hole dia currently is 0.2mm or 0.15mm
- Prepreg thicknesses available in the order of 100-200um.
- Ideal procedure for thin core for SBU; necessary in any case for SBU layers; support for SBU layers.
- Test and QC : somewhat similar
- SBU process not suited for flex bases

MICROVIA/SBU PROCESSES

BENEFITS & DISADVANTAGES

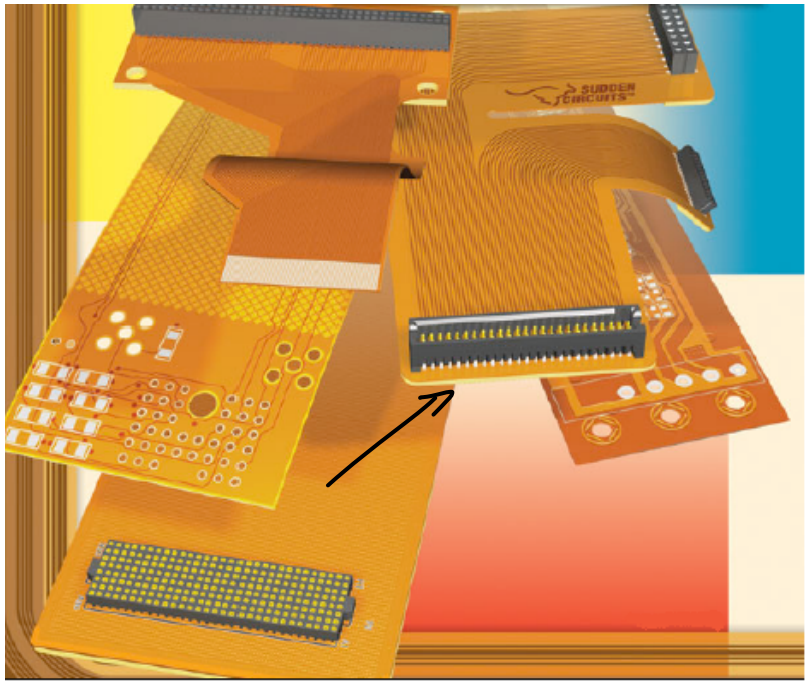
- Parallel processing-high volume; yield; PWB process compatible; ideal for handheld products
- Photovia, laser and dry plasma etch
- Wet chemical etch not popular
- Ideal for redistribution layer in SCM/MCM
- Not suited for high power boards
- Aspect ratio less than 1 in most cases-thinner dielectric by curtain coating
- Adhesion strength between dielectric and Cu crucial for reliability of via
- Very ideal for BGA, FCA, COB methods since it enhances board density
- Board warping disturbs microvias; Tg to be high
- Choose dielectric and FR4 core suitably for DEC and other properties
- Blind vias easy to produce using laser drill- better accuracy in depth drilling
- Enables use of conductive paste for stacked vias resembling through-holes

MICROVIA/SBU PROCESSES

BENEFITS & DISADVANTAGES

- Flexibility in choosing number of SBU layers- top or bottom of core; to some extent; not core symmetric
- Use of additive plating on build-up layers with just enough copper
- Test core before SBU process; removal of SBU layers is tricky
- Use of different dielectrics restricted due to compatibility with laser drilling
- Quality of laser drill is high class
- Same hole cleaning procedures as conventional
- Different dielectrics can be used for different layers
- Increased wiring density; component density in SBU layers
- Dielectric material property is key to SBU and microvia layer reliability
- SBU eliminates TH's and TH components
- Currently some TH components are not available in SMT format; so TH are essential
- Thermal vias in TH format well established
- SBU-flexibility in process, material choices

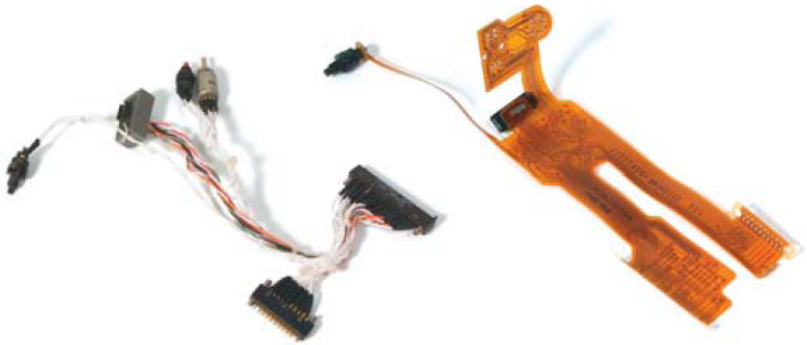
Flex Circuits



Information courtesy of:

- Steve Gurley - Flexible Circuits
- Minco – Flexible circuit design guide
- http://www.pwcircuits.co.uk/flex.htm
- Dupont
- Sheldahl
- Rogers Corp.

Overview

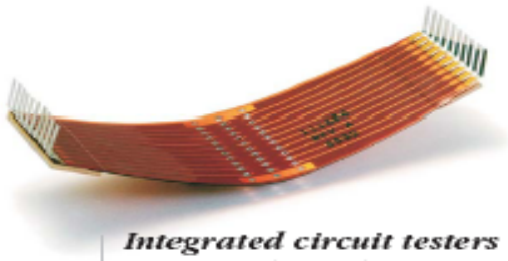


- Originally designed as a replacement for traditional wire harnesses
- An array of conductors bonded to a thin dielectric film
- Bent-folded or shaped to interconnect multiple planes
- Assumes 3-Dimensional configuration
- Flex Circuits, Flexible Printed Circuit Boards, Flexible PCBs

Air bag systems, Engine controls, ABS

Cameras

Cardiac pacemakers

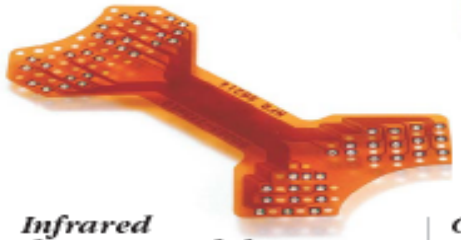


Integrated circuit testers

Bar code equipment

Calculators

Satellites



Infrared detector modules

Clinical analyzers

Military radio

Avionics

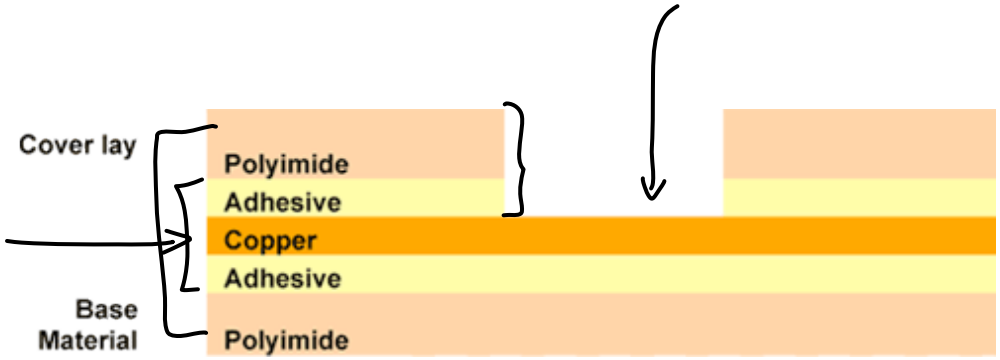
Printers

Drivers

- Point-to-Point wire replacement
- Package size and weight reduction
- Assembly error reduction
- Fast assembly
- Robust connections
- Flexibility during installation
- Improved Airflow
- Increased Heat Dissipation

Elements for Construction

- **Base material dielectric**
  - **Resin + Filler**
- **Adhesive**
- **Metal foil conductor**
- **Protective coatings**
  - **spray/ liquid/ film**



Single sided flex circuit

Substrate

- **Properties**
  - Dimensional stability
  - Thermal resistance
  - Electrical insulation
  - Moisture absorption
  - Flexibility with temperature
  - Chemical resistance
  - Costs
- **Materials**
  - Cellulose-paper film composite
  - Nylon-paper composite
  - Mica composite
  - Rubber tapes
  - Polyimide
  - Polyester, PET, PEN
  - Aramid fiber
  - Fluorocarbon films

Choice of materials

- **Polyimide**
  - ✓ **High temperature**
  - ✓ **Flame retardant**
- **Polyester**
  - ✓ **Low temperature**
  - ✓ **Low cost**
- **Aramid non-woven**
  - ✓ **Low cost**
  - ✓ **High temperature**
  - ✓ **Low tear strength**
- **Fluorocarbons**
  - ✓ **Space/ Military**

cost?

Adhesives

- Provide good bond between substrate and metal foil
- Compatibility with substrate and conductor layer
- Applied under heat and/or pressure
- Properties
  - Peel strength
  - Moisture absorption
  - Electrical properties
  - Temperature resistance
  - Vulnerability to solvents
  - Adhesive swelling/expansion
  - Cross-linking reduces flexibility

Choice of material

- **Acrylic Adhesives**
  - **Multiple soldering applications**
- **Polyimides and Epoxies**
  - **Long duration exposure to temperature**
- **Polyester**
  - **Low cost**
  - **Lower temperature applications**

Adhesiveless Laminates

- **Thinner circuit**
- **Better flexibility**
- **Better thermal conductivity**
- **Better stress performance (mechanical/ thermal)**
- **Manufacturing**

➢ **Vapor Deposition – Vaporized Cu in vacuum chamber**

➢ **Sputtering to film – Cu cathode bombarded with ‘+’ ve ions**

➢ **Plated to film**

Conductors

- Copper
  - Electrodeposited 10-40% elongation
    - Plating and stripping from a cylindrical cathode
    - Columnar grain structure
    - Static applications
  - Rolled / Annealed Cu 25-45% elongation
    - Overlapping horizontal plane grain structure
    - Dynamic applications
- Beryllium-Copper foil
- PTF: Silver, Carbon in polymeric media like epoxy, acrylic, urethane or vinyl based polymers

→ metal particles / polymeric media

Cover layer or Protective coating

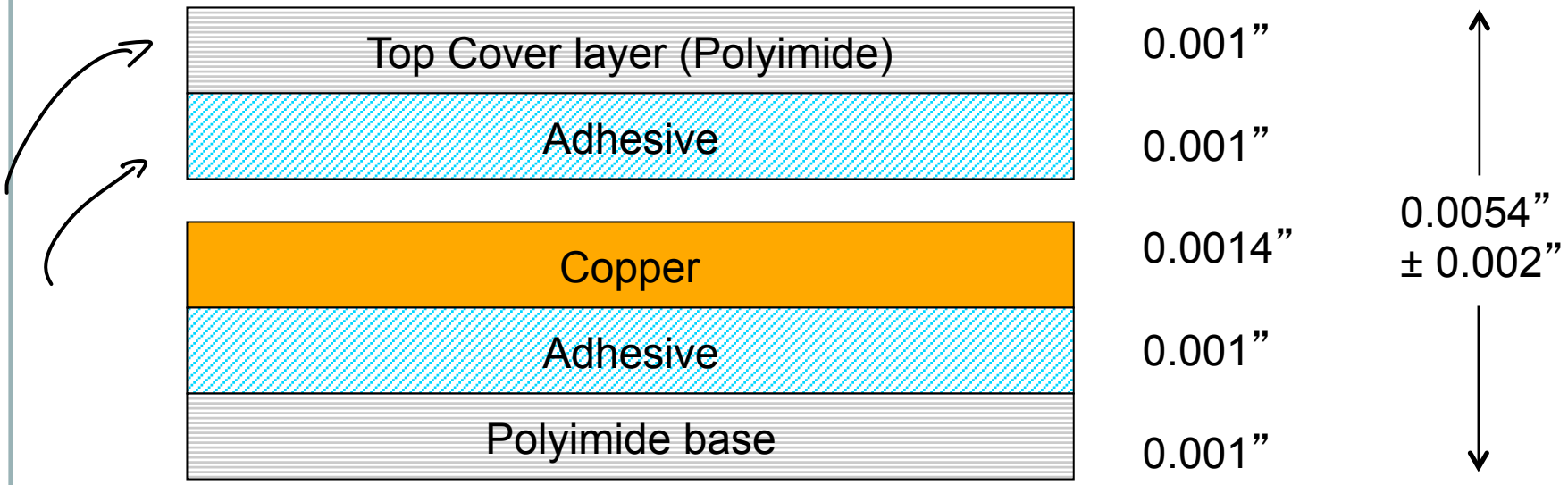
- **Plating**
  - **Solder, nickel, gold and tin**
- **Non-conductive photo-imageable solder masks**
- **Non-conductive cover layers**
  - **Liquid polymeric solutions spin coated and cured**
  - **Screen printing and cured by UV/ IR**
  - **Dry film type cover layers (peel stickers)**

Constructions

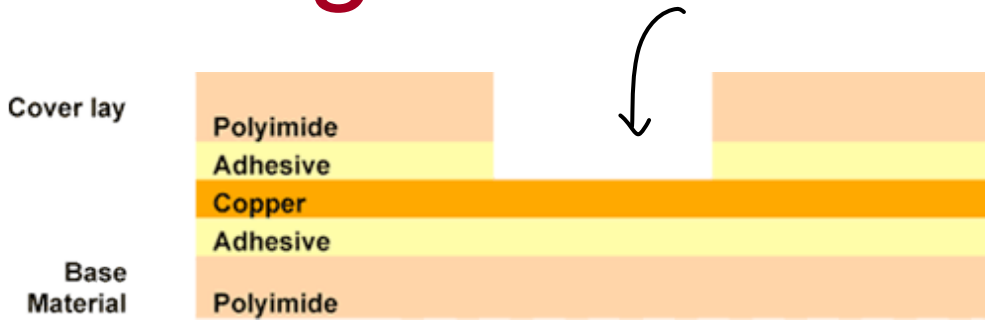
- Single sided
- Double access flex
- Double sided flex (plated)
- Multilayer flex
- Rigid-flex

- FC on flex flip-chip
- TAB flex Tape automated Bonding
- SMD flex

Cross-section of a simple flex circuit

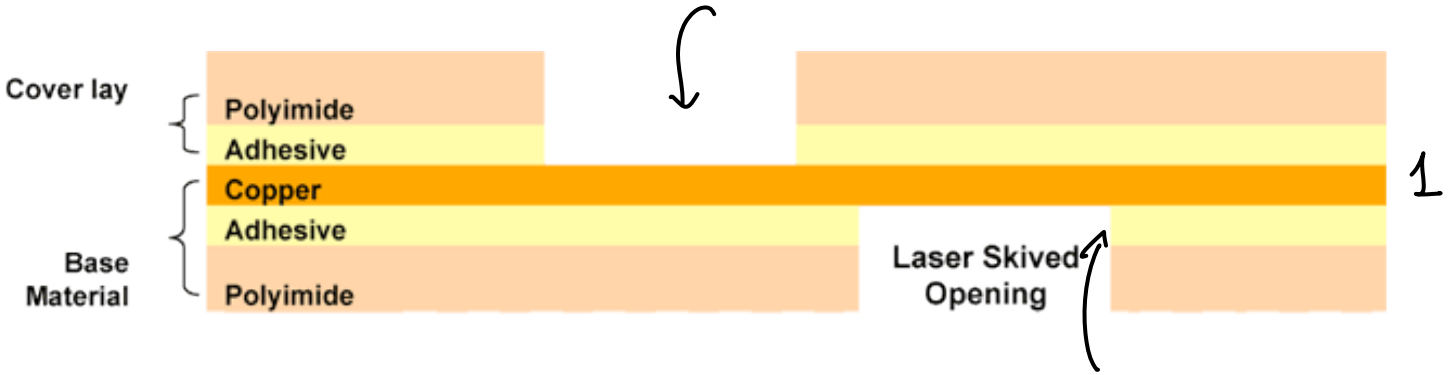


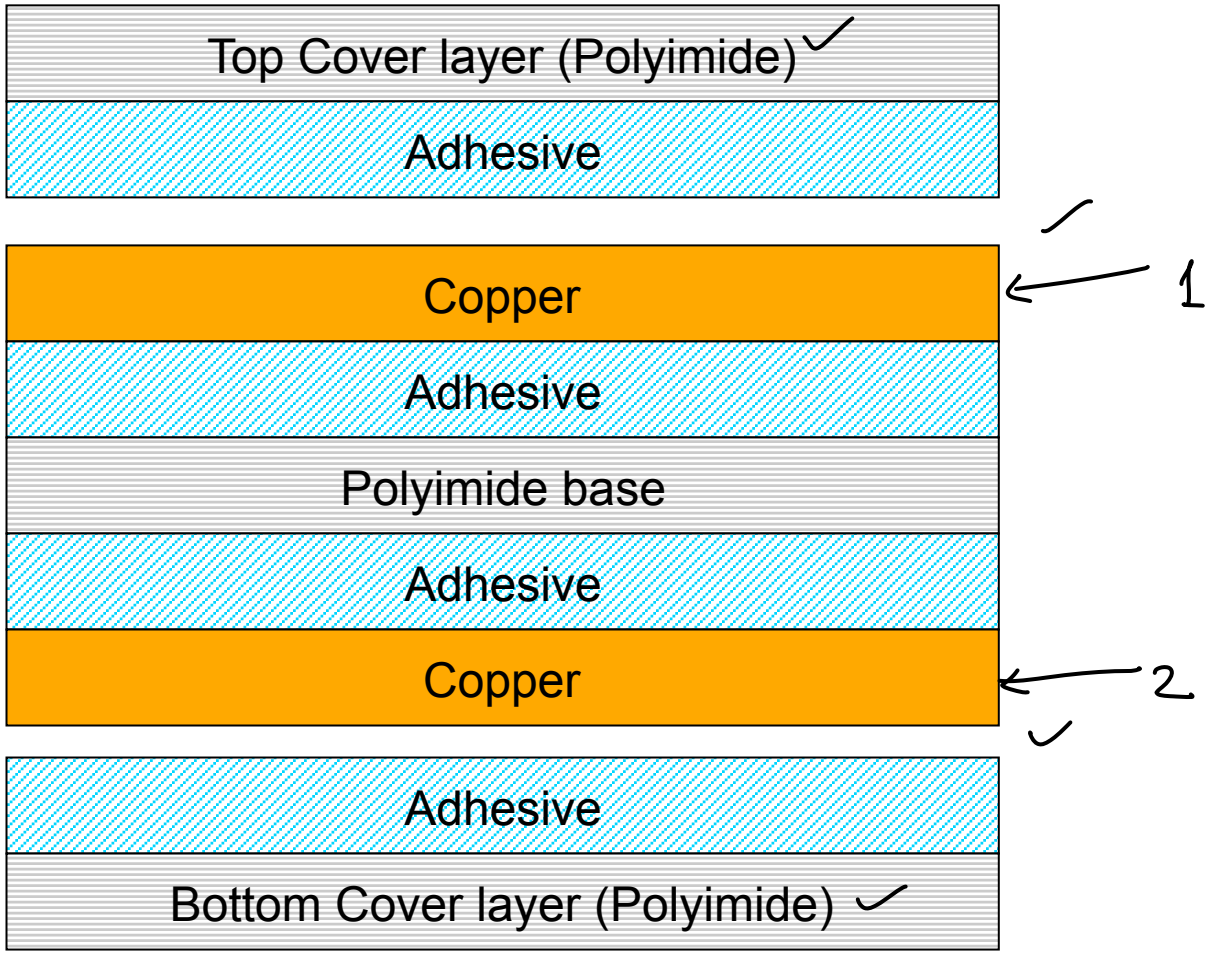
Single sided flex



Single sided flex circuit

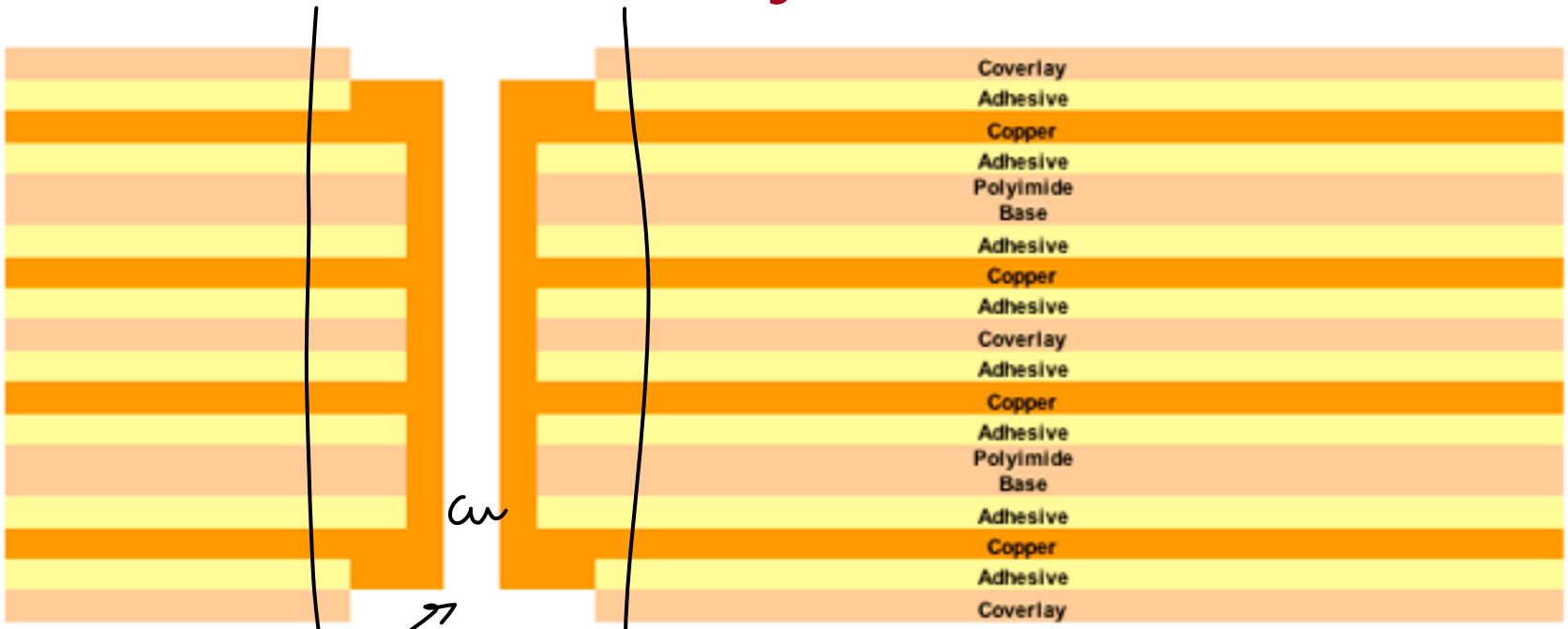
Double access flex



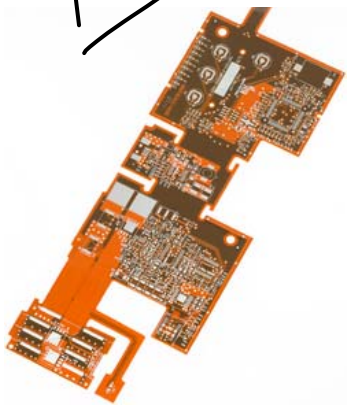


Double sided flex construction

Multi-layer flex

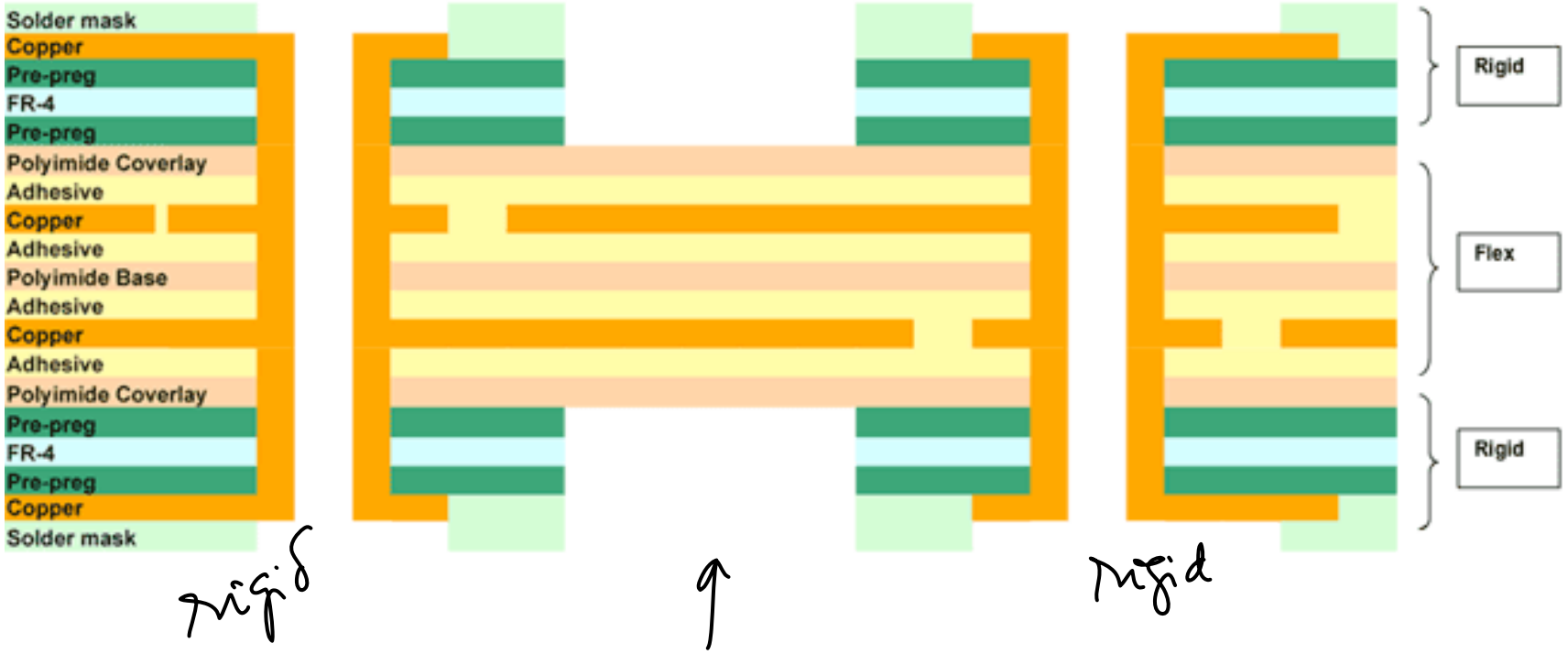


Four Layer
Flex Circuit

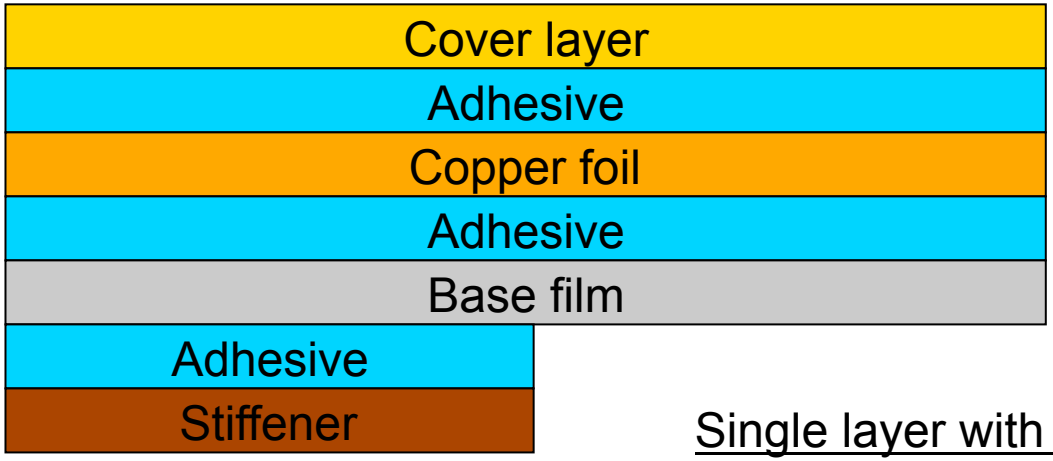


- Plated through-holes

Rigid flex

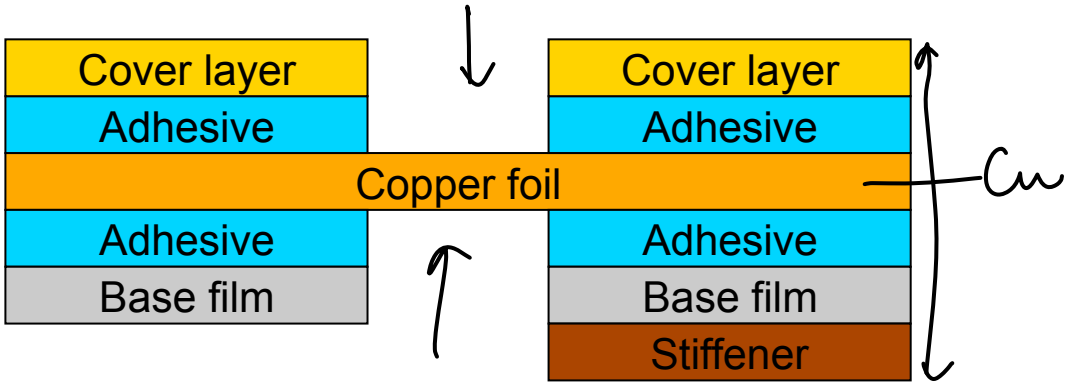


- Coverlay on flex
- Liquid photo-imagable solder-resist on rigid areas

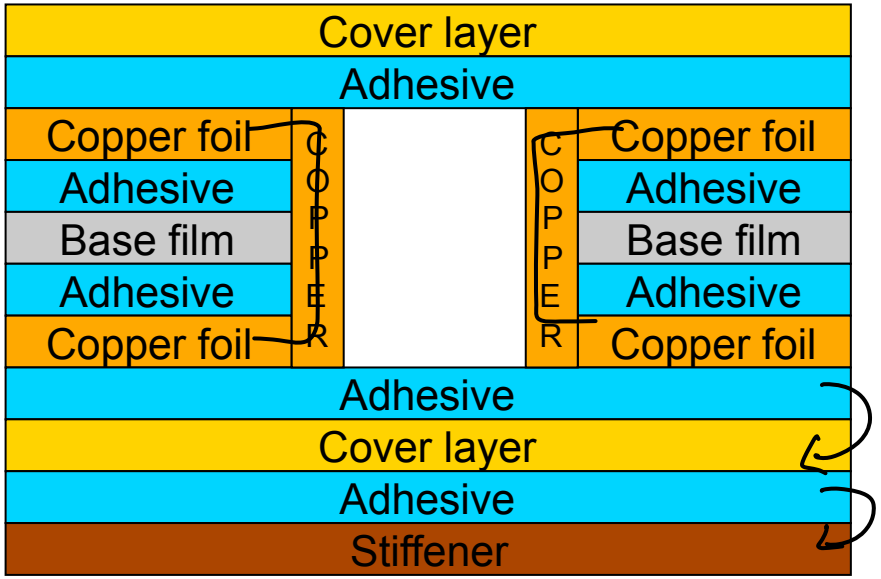


Single layer with stiffener

- Typical stiffener material is polyimide and FR-4.
- These stiffeners can be installed to the top or bottom side of the flexible circuit.
- These provide specific areas of rigidity.
- FR-4 stiffeners are usually installed with pressure sensitive adhesive (PSA).
- Polyimide stiffeners are usual installed with an acrylic adhesive, known as a thermal set adhesive (TSA).



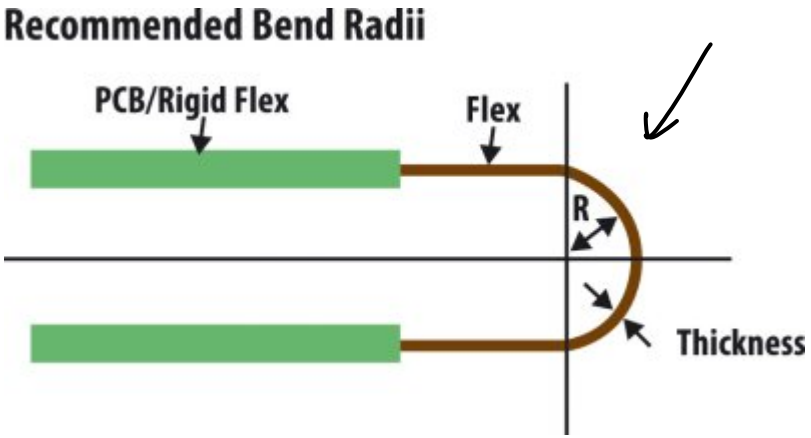
Single metal layer , double sided access, stiffener



Double metal layer with stiffener

Rigid Vs Flex

- Rigid is essentially single plane medium whereas flex can be configured in multiple.
- Flex have 20-30% lower dielectric constant than rigid.
- Thinner construction and better isolation is possible.
- Thinness of flex provides assembly strain relief on component joints as compared with rigid.
- Flex prone to degradation on long thermal exposure.
- Polyimide used in flex circuits absorbs more moisture



Flex Circuit Type	Minimum Bend Radius
Single Metal Layer	3-6 x circuit thickness
Double Sided Flex	6-10 x circuit thickness
Multilayer Flex	10-15 x circuit thickness (or more)
Dynamic Application (Only single sided recommended)	20-40 x circuit thickness (increases in bend radius normally increases life)

Figure Credits: Shereen Lim, Avago Technologies and 'electronicsonline'

- END OF CHAPTER ON PWB TECHNOLOGIES

- TUTORIAL SESSION TO FOLLOW

TUTORIAL CLASS- ELECTRONICS SYSTEMS PACKAGING TECHNOLOGIES

NPTEL VIDEO LECTURES
AUTHOR: G V MAHESH, CEDT, IISC, BANGALORE 560012

THIS COVERS DESIGN AND MANUFACTURING TECHNOLOGIES CHAPTERS

1. Some SMD *capacitors have a case form of 01005*. What are the dimensions of this capacitor?

01 005 .01 inches x .005 inches

2. A HDI *substrate has a 1-4-3 construction*. What does 1-4-3 mean?

4 – core
1 – top sBU
3 – bottom sBU layer

3. Name three *etchants commonly* used in the PWB industry.
   a.
   b.
   c.

4. a. The black colored area in an Ag-halide photo tool *blocks UV light*.
   True or False? _____

   b. YAG laser *cannot drill copper* but can drill through a dielectric.
   True or False? _____

5. FR-4 is a standard laminate material used in PCBs. What does 'FR' stand for? Name the *key ingredient/element for the unique property.*

6. What do the following terms stand for?
   a. B^2IT >>
   b. *ALIVH* >>

7. a. A positive photo resist when exposed to UV light *becomes harder and insoluble in developer*.

True or False? _____

b. *Ni-SS metal foils* are normally used to make *stencils for solder paste printing*.

True or False? _____

8. Mention *two points favoring aqueous developing* as compared to organic developing for photo resists.

a.

b.

9. A PWB features 0.2mm mechanically drilled holes (smallest) in a 1.6mm substrate. What is the aspect ratio of the PWB? Do you forsee any difficulty with this design during fabrication or not? What is your suggestion for ideal AR?

$\frac{1.6\ mm}{0.2\ mm} = 8$

10. Name *two etch resists* for TH boards.

a.

b.

11. What is the *purpose of 'flying probe* test' in finished PCBs?

12. There is a need to coat a *liquid dielectric on a copper plate to about 25 microns*. Which coating method or methods would you employ? Which gives more yields?

13. Platinum is used as the *catalyst for electroless process* in TH-PCBs?

True or False?_____

14. Copper needs to be protected from atmospheric oxidation after PCB fabrication. *Other than Sn-Pb what other surface protection* can you provide? Indicate thickness.

15. Why is *HSS drill bit not used in high-speed drilling* of copper-clad laminates-glass/epoxy based? What is your choice?

16. Itemize *three electrical properties* you would look for in a copper-clad laminate.

    a.

    b.

    c.

17. Give two reasons to *minimize undercut or maintain high etch factor* during etching.

    a.

    b.

18. What is a *B-stage resin*?

19. What are the *standard thicknesses of copper-clad laminates* available in the market?

20. Name *two possible defects* expected in microvias of a HDI-PWB.
    a.

    b.

21. Name *one advantage of 'mitring'* tracks in your design, <u>from a manufacturing standpoint</u>.

22. Name *two organic resins for PCB substrate materials under the organic substrate category*: (other than epoxy)

    a) _____

    b) _____

23. Mention *two MERITS of a Diazo photo tool* compared to a silver halide photo tool.

    a.

    b.