Printed Circuit Board Introduction: Materials / Selection

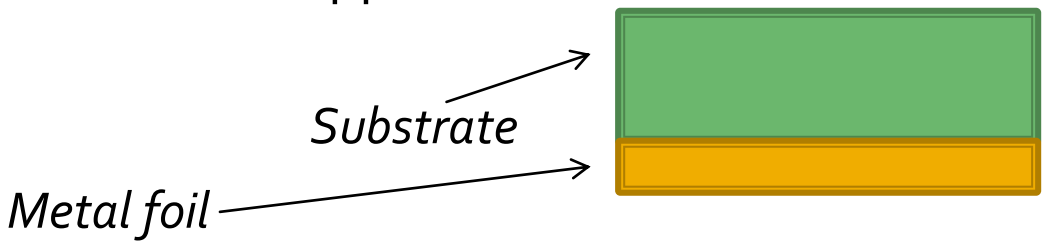
General Topics

TOPICS:

- PCB's general
- Board material
- Conductor material

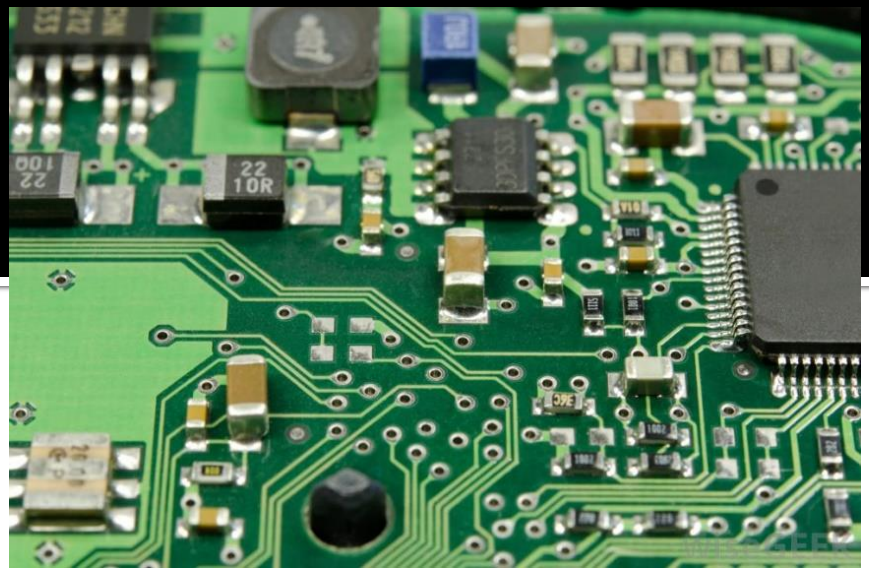
PCB Basic construction

- **How do you prototype / assemble more complicated circuits?**
- **PCB's are used both in prototyping and production stages.**
- **Printed Circuit Board definition**: "**Metal foil** conducting patterns bonded to a **substrate** for support"



- Substrate: **Insulating base material (fiberglass / phenolic / Teflon)**
- Metal foil: **Copper**

PCB Basics…



- **Purposes of PCB's**

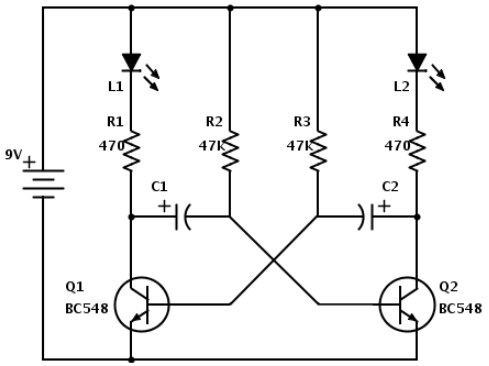
- Provides electrical wiring path (replaces wires)
- Mechanical support of components
- Allows mounting of circuit to enclosure or chassis

What are the advantages of PCB's over hand wiring:

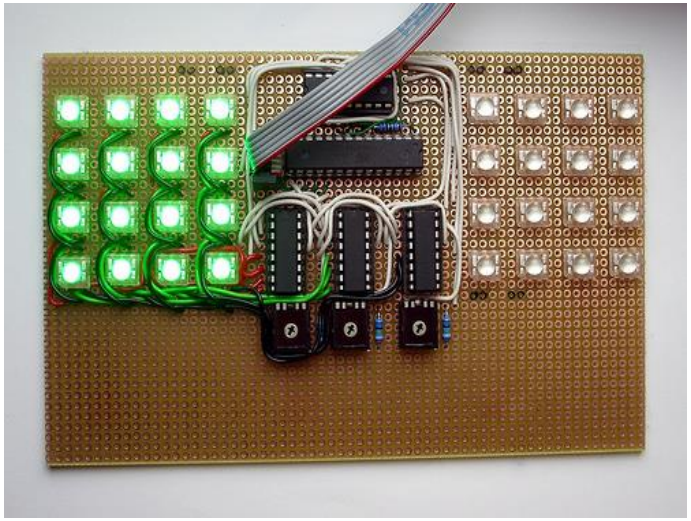
- *Miniaturization* and *modular design*
- Uniformity in production
- Reduce wiring / assembly errors (not eliminate)
- Minimize assembly and inspection time
- Allows mass production / automatic assembly methods

Advantages of PCB's

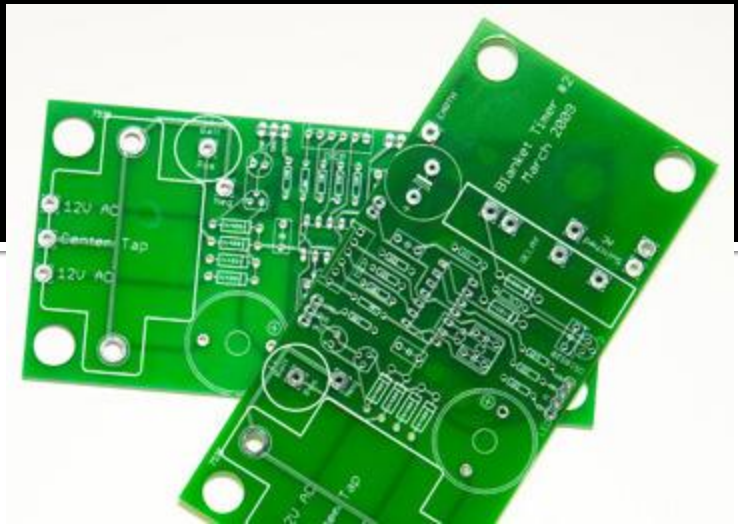
- Other advantages:
  For Manual Prototyping,
  <u>you still need to</u>:



- Create a schematic
- Layout parts
- Use perfboard / substrate material

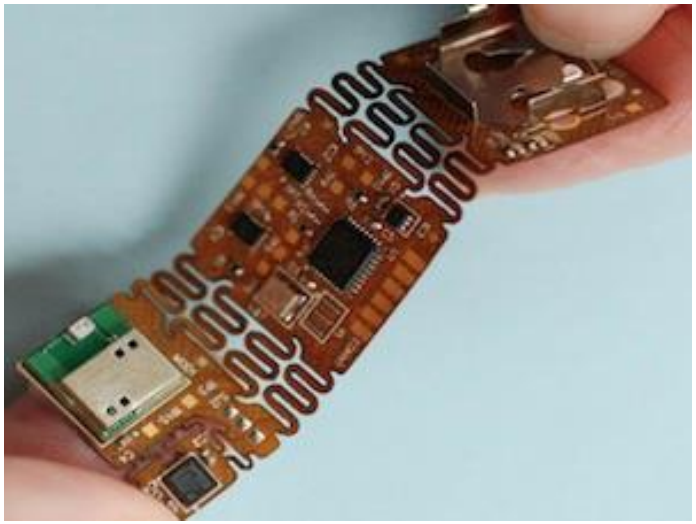


2. Board materials



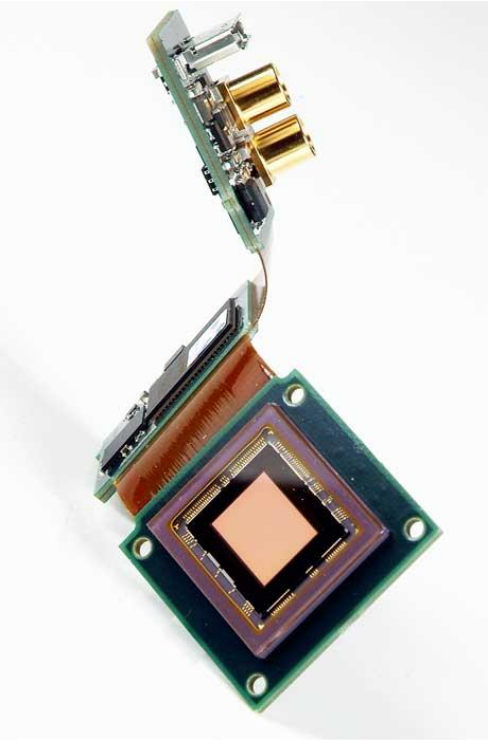
- Categories:
  - Flexible / Rigid
  - Single sided / Double sided / Multi-layer

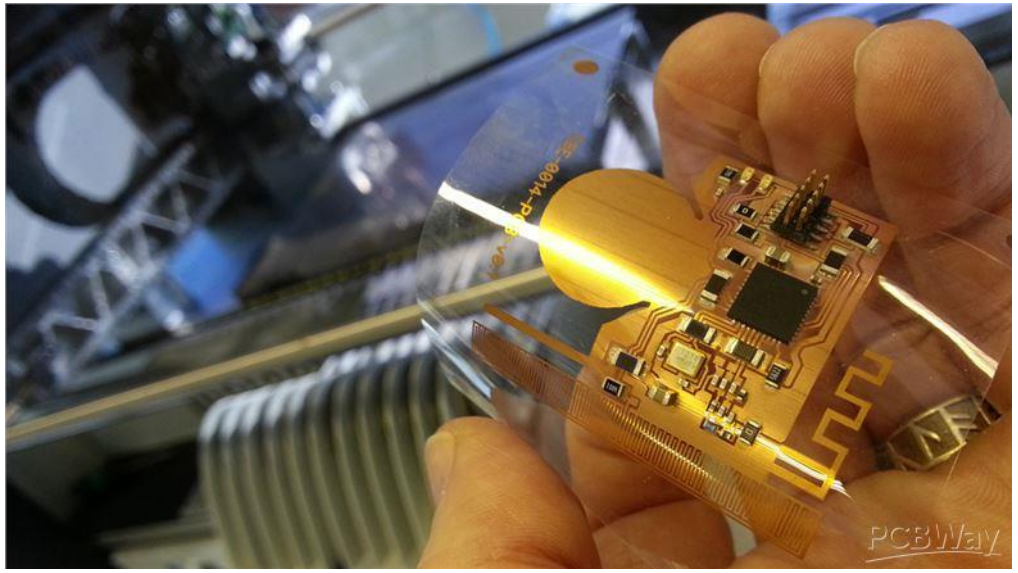
- **Flexible Materials:**
  - Used as multi-conductor connectors (Flexible Printed Connectors)
  - Used as complete PCB's



Advantages of flexible / pcb's:

- Allows conforming to different 3D shapes
- Flexible for moving assemblies

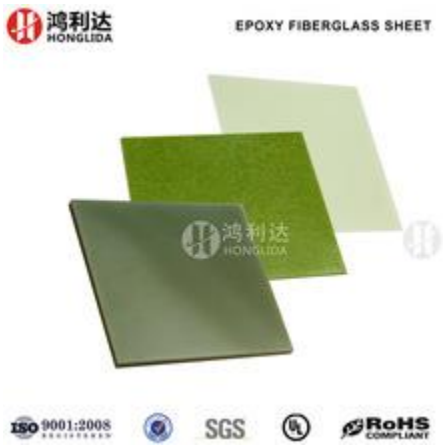




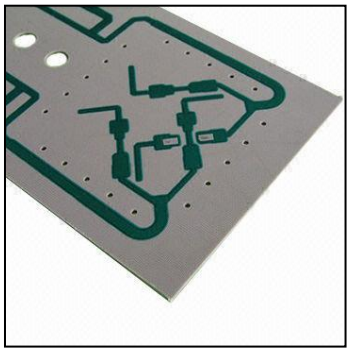
Rigid board materials

- Usually composed of thermosetting plastics: *resin* in a *reinforcing material*

- Base material: paper, glass, fabric
- Resin: Phenolic, epoxy, Teflon



PCB Substrate materials



- **Most $ Teflon –**
  - microwave applications
- **Mid $ Epoxy / melamine (middle of road)**
- **Low $ Phenolic**
- ***However, material cost not as crucial as reliability***

Board Materials, continued…

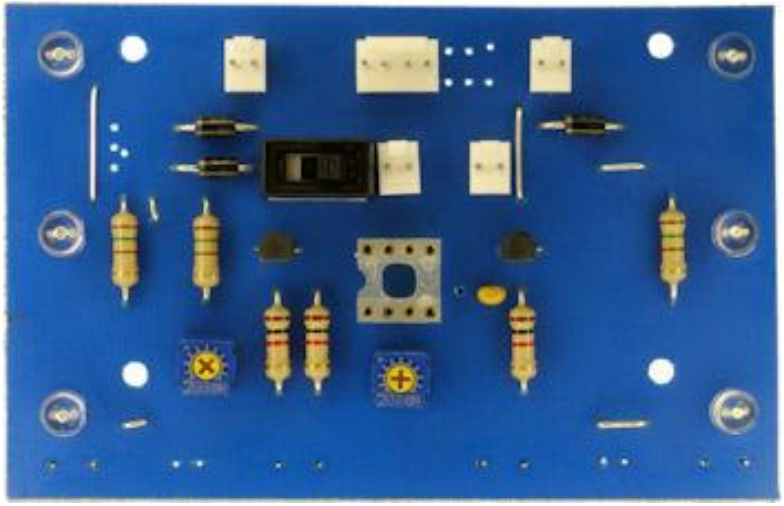
- Board materials use a **NEMA rating**
- NEMA = National Electrical Manufacturers Association
- Example: XXXP = 10 MHZ! (This would be Low frequency for digital signals)

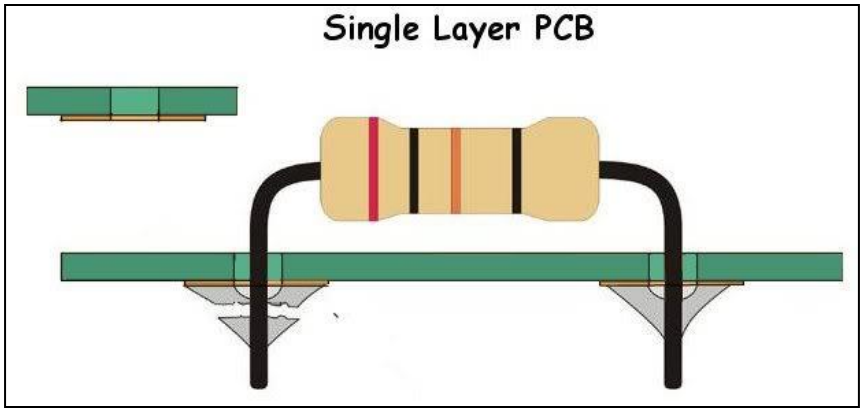
Board Materials, continued…

- **Most common** used NEMA rating: **FR-4**
  - "FR" =Fire Resistant
  - Up to 40 MHZ

Single / Double sided boards

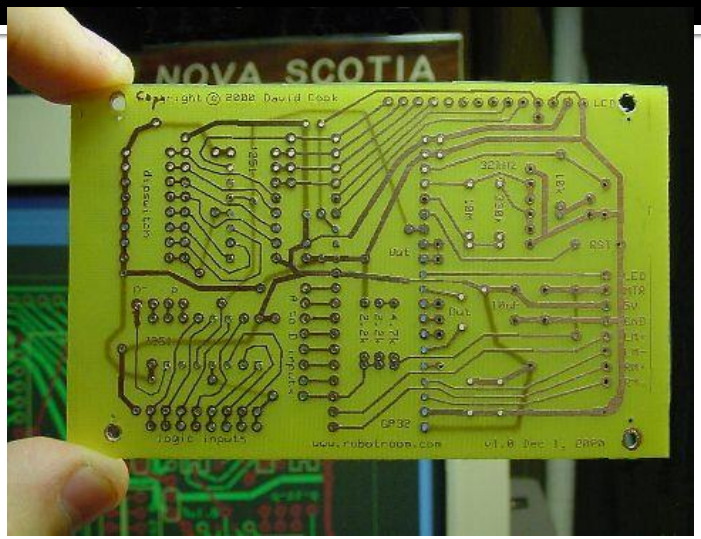
- Single Sided:
  - **Simple Circuits**
  - Inexpensive
  - Connections (traces) only on one side

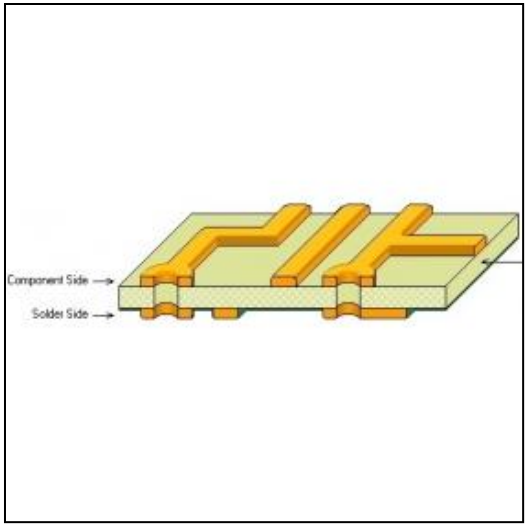




Single / Double sided boards

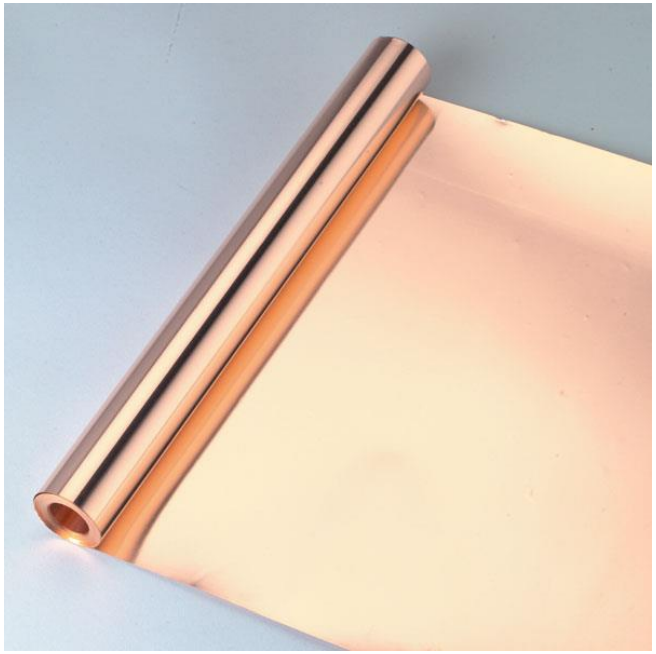
- Double sided:
  - More complex circuits
  - Reduce overall size
  - Cost increases
  - More complicated process (requires plating of holes)



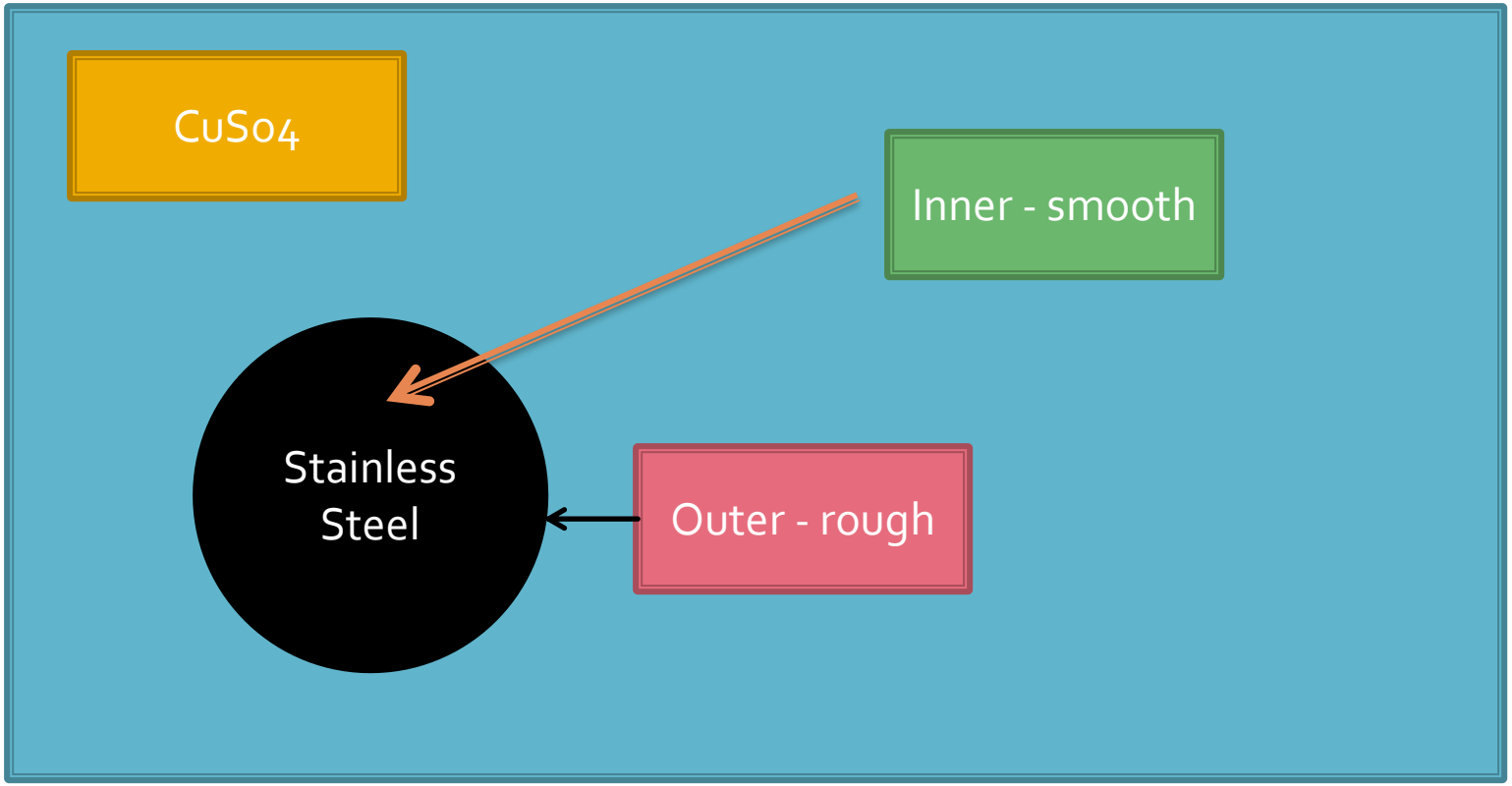


3. Conducting Material - Foil

- **Most common material: Copper (Cu)**
  - High **Conductivity**
  - High solderability



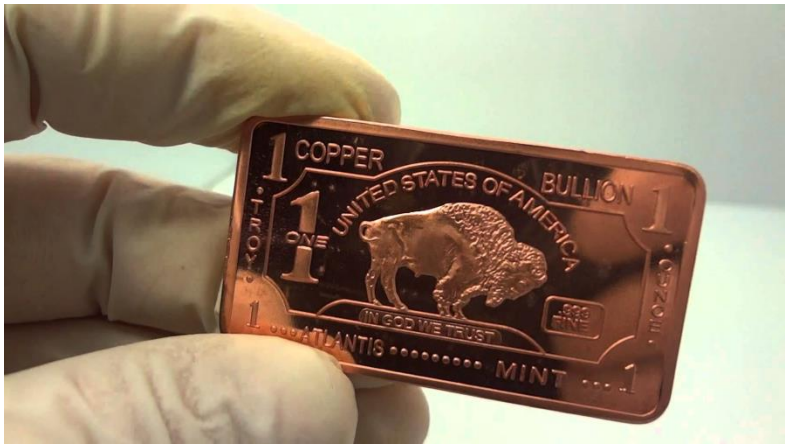
Electro-deposition of copper

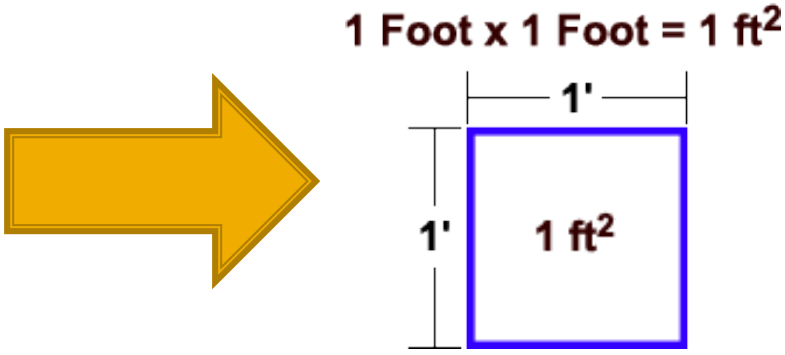


Electro-deposited (used almost exclusively in PCB's)

- **Foil thickness not specified in measured thickness, but in weight / area (oz. / ft²)**

- NOTE: **As the weight doubles, the thickness doubles.**

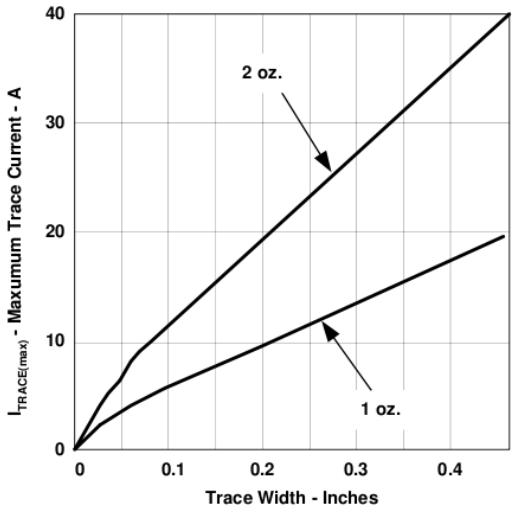




Plating material, cont'd

- Why is thickness so important??

- **Thickness directly affects current carrying capacity** (Ampacity) along with **trace width** and **ambient temperature**.
- Circuit board Ampacity can approach 50 amps!



Current carrying of a copper PCB trace for a 20 °C temperature rise.

Bonding – metal to substrate

- Bonding – adhesion of copper to substrate:
  - Bond strength (most important – if it came apart, circuit would be destroyed)
  - Hot solder resistance