

3.37 (Class 6)

Today:

Cold Welding

- Handout: Investigations on Pressure Welding (graph reproduced on board)
- Diagram on board showing how oxides break up to expose metal surface
- Hard oxides vs. soft oxides
 - Hard oxides break up and metal can extrude through
 - Soft oxides spread out over surface, like the oxide on copper, need about 80% deformation to get bond
 - Indium is soft metal but has a hard oxide is the easiest metal to cold weld
 - Hermetic seal on early semiconductor cans
 - Al is next easiest, oxide in crystal form is sapphire, corundum is just below diamond in hardness
 - Two spots for Al, Al and Al alloy
 - Silver, doesn't form an oxide, but have sulfur in the air
- Metals and Controls Division of TI
- Cecil Green (MIT grad in geology, mid 1920s) bought small company that made instruments for oil fields, bought small firm "Metals and Controls" in Attleboro, MA that made bimetal strips. They do lots of cold bonding. Why in Attleboro? Gold capital of US. Leech and Garner used process of sterling silver on brass, started this for gold-filled material. Brass with a layer of gold. 80% deformation, rolled inch down to 0.2in. "Metals and Controls" found that hexavalent chromium from plating solution was a carcinogen. Late 70's all autos had chromium-plated bumper. Plants had to be shut down. Plating stainless steel on steel to make bumpers. Great growth for Metals and Controls. But next round of cars moved to aluminum bumpers with black rubber strip. Then mid 80's went to plastic bumper. Now in 90's start to see chrome plated bumpers again.
- Oil City, PA 1900 refinery. Riveted storage tanks from 1920. Had one blow up. Old equipment. There for two days. First day wondered why this plant still operating. Second day realized. Had been spilling oil. Cheaper to keep running the plant at a loss than to clean it up. When first started drilling for oil in Titusville, the way they would transport the oil was by just floating it on the river.

Microelectronics Joining

- Lots of bonding technology
- Electronic packaging is composites technology: many different materials in one structure
- Difficult to recycle
- Real estate on circuit boards at a premium
- Multi-layer boards
 - Plastic, with tinned copper, then adhesively bonded in laminating press

- Level of interconnect
 - Level 0: on the chip
 - Level I: semiconductor to its package
 - making a connection from metal pad vapor deposited on the surface of the semiconductor to the package.
 - Level II: package to the Printed Circuit Board (PCB)
 - Level III: subsystem
 - Example, inside a VCR, how connections are made between several circuit boards
 - Level IV: system
 - Example, VCR to TV
- Chip-on-board technology, Intel sells chips for placement directly on board
- Rent's Rule: I/O to # of circuits on chip
 - Microelectronics packaging handbook (covers levels I – IV)
- How to make more than about 400 I/O connections on a chip that is about 1cm on a side?
 - See diagram on board, Si bonded to Al₂O₃ substrate
 - Chips develop say 10W, so have approx 10W/cm² (this is about the same as a Bunsen burner)
 - Used to have copper rods that would carry helium gas to cool the chips
 - Use a polymer adhesive with silver powder that has good thermal conductivity that carries heat into the substrate.
 - Then have other heat sinks that carry heat away from substrate
 - 140degF will burn skin if held in contact for say 10sec
 - 180degF will burn skin within fraction of second
 - McDonald policy was to brew coffee at 180degF
 - Perimeter bonding
 - Sewing machine apparatus to feed wire, need .007in spacing between pads for clearance to apply thermal compression weld
 - About 50 bonds/side
 - Might get say 240 I/O's with wire bonding
 - Might add a second row, but then lose real estate on chip
 - TAB (Tape Automated Bonding)
 - Example with Intel Pentium chip handed out in class
 - Polyamide plastic tape
 - Each wire (created by photolithography) about .002 wide on .004 centers
 - Approx 400 I/O's for tabbed tape
 - Inner lead bonds already made by Intel
 - Outer lead bonds: squeeze these onto a circuit board, solder using a heated tungsten head
 - Needs precise alignment