3.37 (Class8)

Review

C4 (Area Array) 1000-2000 I/O

Cold welding

- Aluminum is the second easiest metal to cold weld
- Make near perfect welds in aluminum wire

Adhesive Bonding

- Unique in that it does not remove surface contamination
- Type I Adhesive Bonding results from attractive force of wetted liquid at the interface (lowers the interfacial energy, van der Waals bonds, inherently weaker than primary bonding)
    - Example: adhesive to attach rear-view mirror to the windshield
- Type II AB mechanical interlocking
- Contact angle <30deg required for wetting (usually want something less than 10deg), young's equation: metals are nice, strongest solder/braze joints

Today

Surface preparation

- Rough surfaces wet more easily (surface area is greater, reduced surface energy)
- Anodizing aluminum
    - Aluminum oxide growth makes a great mechanical interlocking surface, anodized coating
    - If want corrosion resistance, need to seal the surface, otherwise have channels down to the metal
    - Seal it by boiling it in hot water to grow oxide between cells, sometimes also use sulfuric acid
- Phosphate steel (coke/pepsi are phosphoric acid on iron)
    - First used for lubrication, if want lubricant to adhere to the surface, want to have a porous surface, use calcium stearate (soap), have a thick layer of lubricant
    - Cold heading, start with rod, shear it, then phosphate it so that it can be worked multiple times, couldn't do this unless surface was prepared
- Titanium anodized, surgical instruments, can anodize with different voltages, change thickness, changes color
    - Anodized titanium jewelry
- Chromates can also be used (but create environmental hazards in applying)

Stefan equation

- Time to squeeze a viscous liquid between plates

    - J.J. Bikerman, The Science of Adhesive Joints, Acad Press, 1961
    - None of the modern books on adhesives go through this
- Force*time product = see equation on board
    - Viscosity
    - Initial and final separations
    - Radius for a circular disc
- Looking at different forces, viscosities, radii, and separations
    - Water at given parameters 7.5ms
    - As the joint gets thinner, time gets longer
    - Also works in reverse, how long will it take the joint to separate as the viscous liquid flows with time
    - Start with something that forms quickly, then change it so that it lasts a long time (by changing the viscosity)
    - Viscosity is measured as a shear stress, how fast it moves at a given shear stress
        - Gas approx 10^-3
        - Water approx 1
        - Molasses about 100, 1000
        - Solid approx 10^10 or 10^14
        - Highest viscosity ever measured, of Finnish coastline 10^22
    - Can increase viscosity by an order of 10^10
        - 10^10 sec is many years
- Filling bottles at rate of about 24/sec, also need to put the label on within a short period of time, so need an adhesive that doesn't take long to form
- How to change a liquid into a solid
    - Freeze it
    - Dissolve something in a solvent and then let it evaporate (like licking a postage stamp)
    - Chemical reaction (epoxy with two elements that solidify based on a chemical reaction)
- Homework: think of all sorts of adhesive, ask self by what method this was done.