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)
    o 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
    o Aluminum oxide growth makes a great mechanical interlocking surface,
      anodized coating
    o If want corrosion resistance, need to seal the surface, otherwise have
      channels down to the metal
    o 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)
    o 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
    o 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
    o Anodized titanium jewelry
  • Chromates can also be used (but create environmental hazards in applying)

Stefan equation
  • Time to squeeze a viscous liquid between plates
  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.