

Cu Erosion in Liquid Soldering Processes

Vitronics Soltec and NPL Case Study

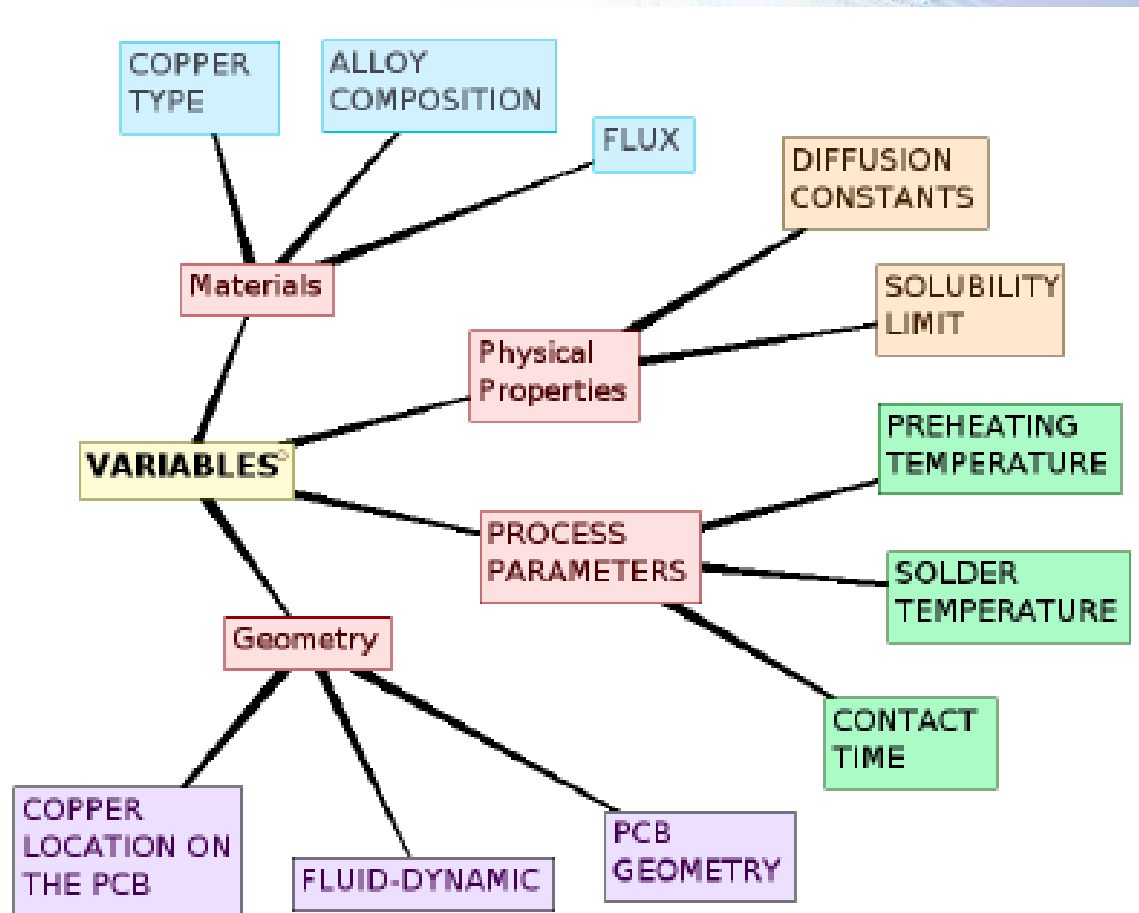
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Findings

- During soldering Cu is dissolved with Sn to form intermetallic which result in the formation of good solder joints.
 - Intermetallic thickness: Typical 1 – 3 microns. Up to 5 microns
- Cu dissolution is a problem when is excessive. It produces lack of electrical interconnection and decrease in reliability.

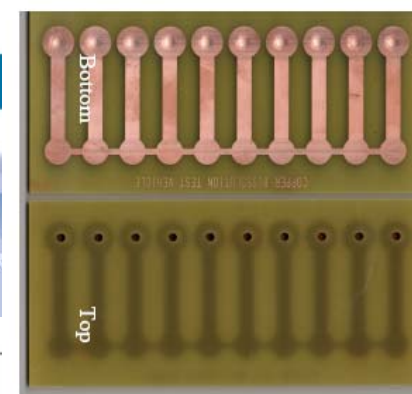


Factors that Affect Cu Dissolution



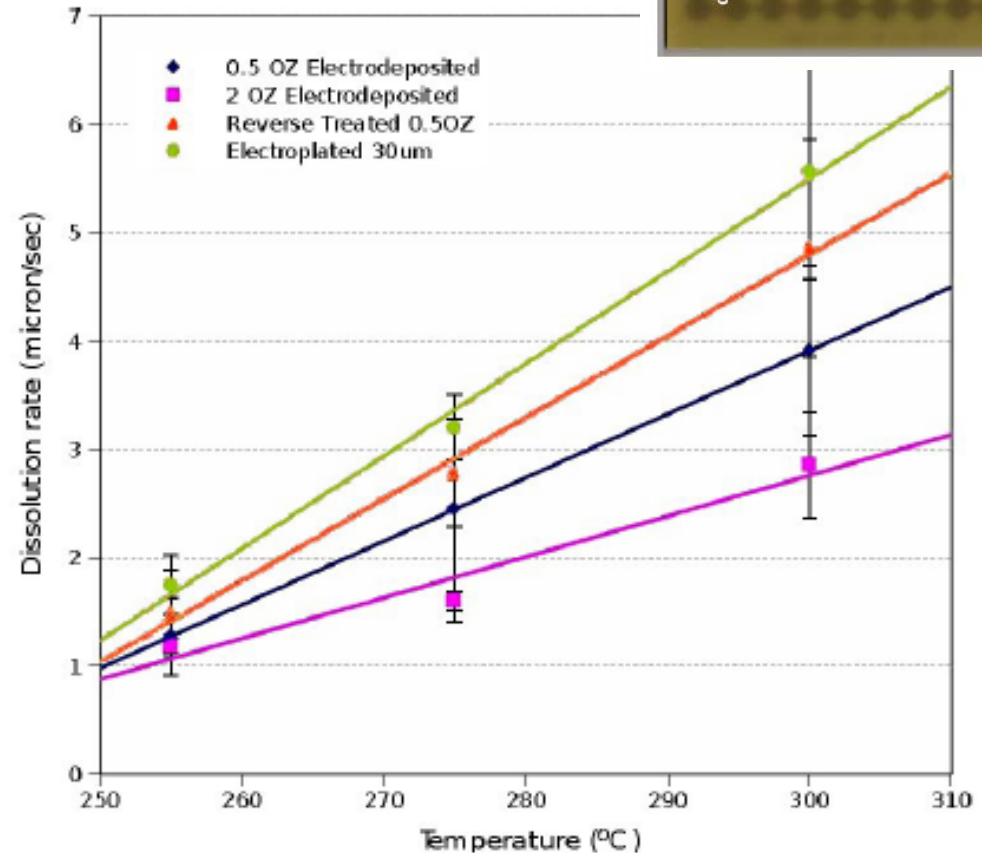
Effects of Materials

- Minimum Cu thickness in PTH
 - 20 microns and 18 microns in small vias
- Cu dissolution varies depending on surface finish
 - Ni/Au boards dissolution is minimum.



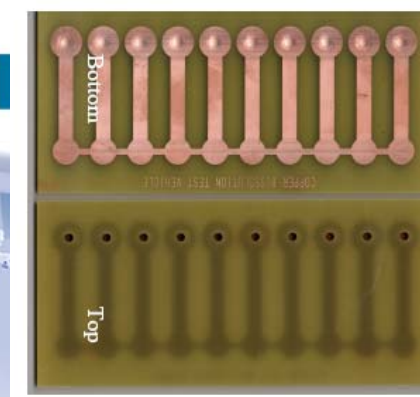
Effects of Materials

- Dissolution rates depend on Cu types:
 - Electroplated, reverse plated, and electropolished
- Electroplated Cu suffers the highest dissolution followed by reserved plated

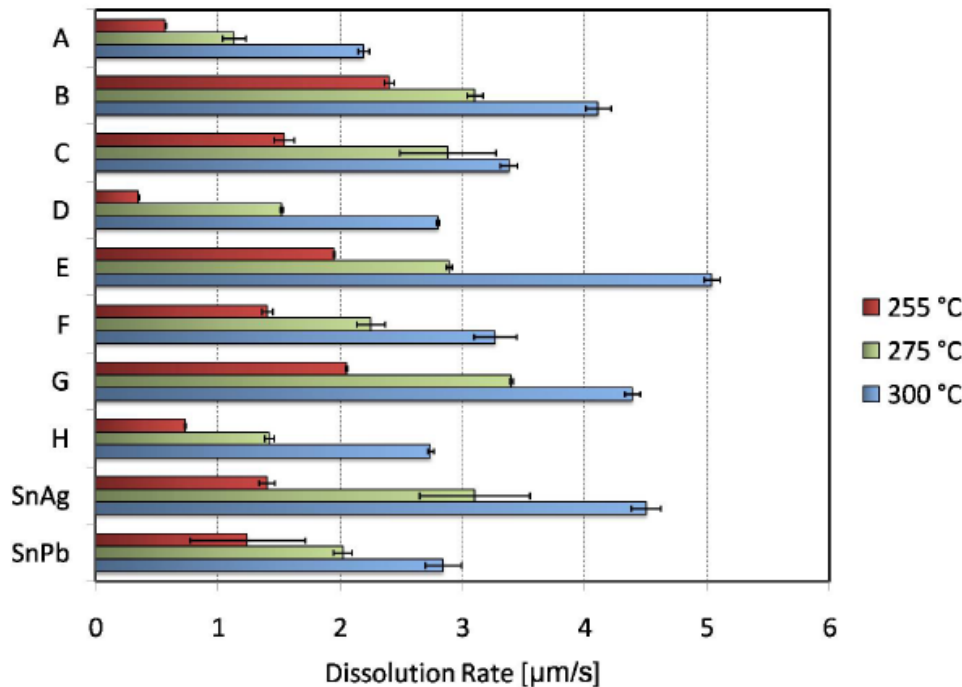


Alloy: Sn/Cu

Flow rate: 1.35 cm³/s



Effect of Materials



- Dissolution increases with temperature
- Sn/Pb is not the alloy with the slowest dissolution
- Alloys with less than 0.3% Ag have slower dissolution rates than Sn/Pb
- Higher temperature dependence was found with alloy E, D, and G

Dissolution rates of commercial alloys at 3 temperatures

Flow rate: 1.35 cm³/s (similar to a wave process)

Effects of Processes

- Reduce soldering temperatures and contact time.
- Optimize pre-heating process
- Assembly process – from highest to lowest dissolution rates:
 - Rework
 - Selective soldering
 - Wave soldering
 - PCB solder levelling
 - Manual soldering/de-soldering
 - Reflow soldering

Effects of Processes Selective Soldering

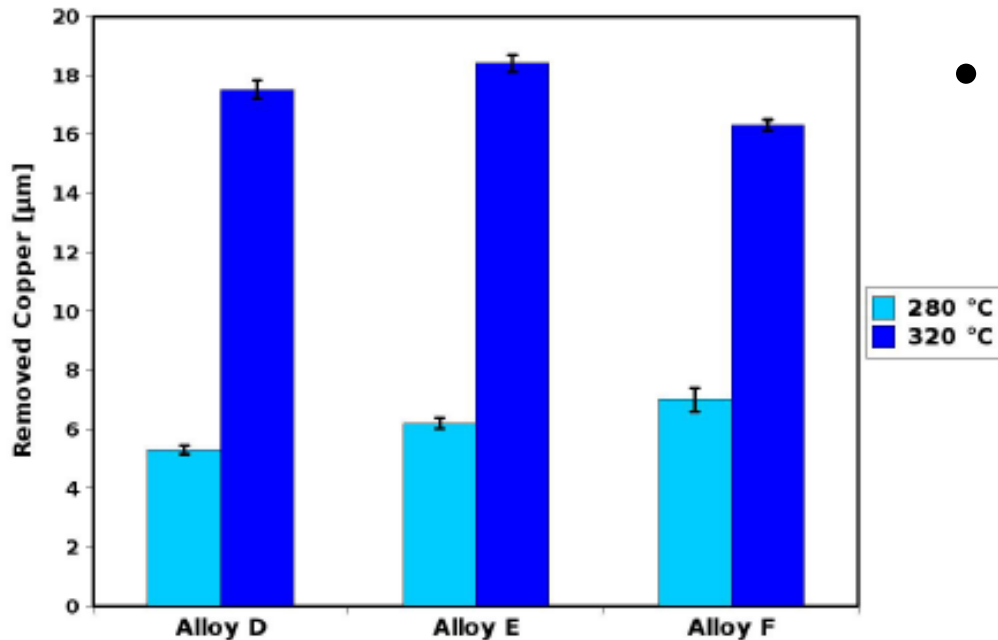
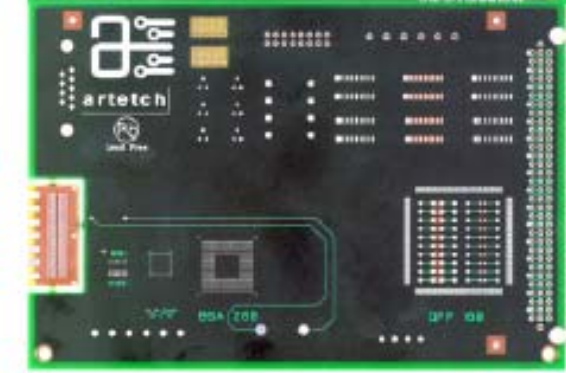


Figure 34: Removed copper on the PCBs after soldering.

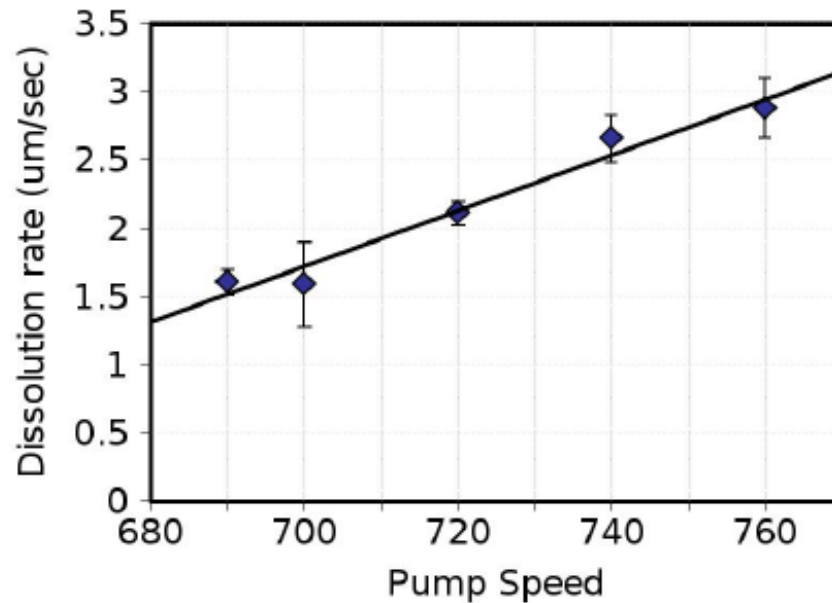
Alloy D: 0.03%Ag and 0.60%Cu

Alloy E: 0.29%Ag and 0.72%Cu

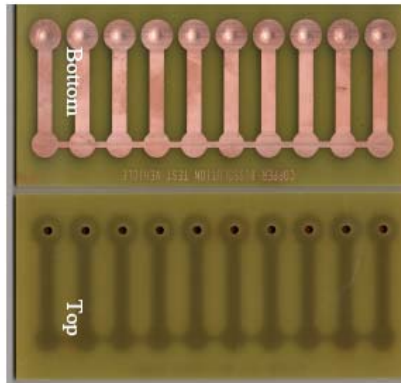
Alloy F: 3.70%Ag and 0.73%Cu

- Alloy D was the best alloy at 280°C but at 320°C the reduction of Cu was much higher than previously tested.
 - Possible cause: uncontrolled flow rate during testing
- Alloy F had the worst performance at 280°C and alloy E had the worst performance at 320°C

Effects of Processes

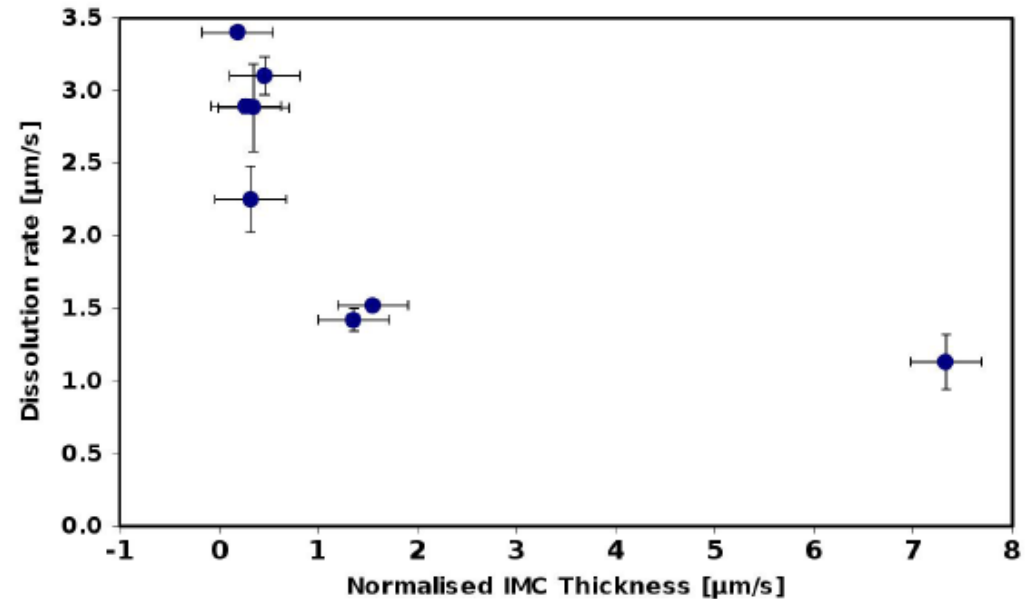


- Dissolution rates for SnAg at 275°C
- The dissolution rate increases linearly with pump speed
- Flow rates depends on pump speed, temperature, and solder alloy composition
- No solder machines measure or indicate flow rate



Intermetallic and Cu Dissolution

- Increasing intermetallic thickness correlates with reducing dissolution rates
- The intermetallic acts as a barrier for Cu diffusion. Thicker intermetallic also indicates that I has reduced solubility





Summary

- New generations of alloys have significantly lower dissolution than the first alloy.
- Silver is problematic at concentrations of above 0.3%.
- Alloy types tested at the same temperatures can outperform Sn/Pb.
- Dissolution increase linearly with temperature.
- Dissolution increase linearly with flow rate.
- Dissolution has an inverse correlation with intermetallic thickness.
- Cu types were significant. Electroplated Cu resulted in highest dissolution rate and electrodeposited had a lower dissolution rate.