In-Air Brazing of Titanium Joints

Ti-copper and Ti-304 Stainless brazed joints in air

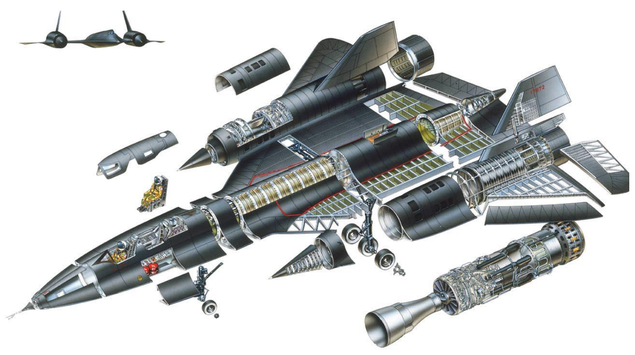
Ben Wright, Gus Barnes, Angelina Hsu

Alexander Shapiro

Background

Titanium tube-frames are particularly valuable in the aerospace industry due to titanium's high strength to weight ratio. Classical methods of producing these frames are either

- Welding
  - Extensive purging and shielding process
  - Highly skilled welding technicians
- Vacuum Brazing
  - Time consuming
  - Limited in size
  - Expensive equipment

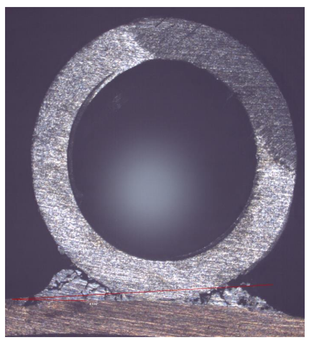


Motivation

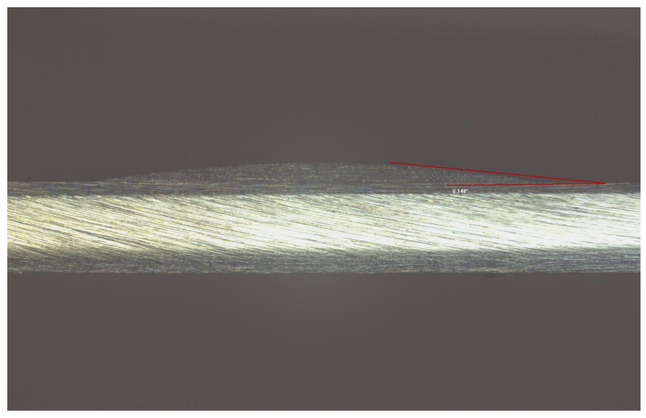
Through this project, a method for brazing titanium to copper and 304 stainless will be developed, this will allow joints between titanium and other metals to be produced more quickly and reliably.

Objectives & Approach

- Determine wettability of braze fillers in all materials involved (copper, Titanium, 304 Stainless Steel) when brazed in air
  - Wetting tests on coupons
  - Wetting tests between tubes and coupons
- Produce tube-in-tube specimens for mechanical testing and microstructural analysis



Wetting test between Ti tube and copper coupon



Wetting test of Ti-Braze filler metal on titanium coupon

Conclusions

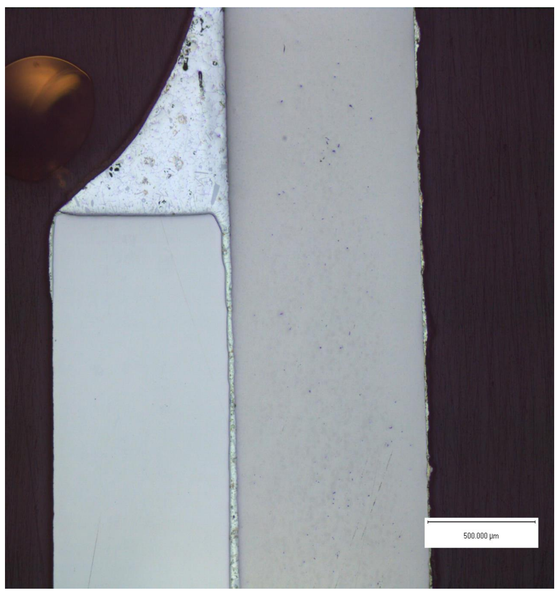
- Both braze materials were able to wet out on titanium in air and produce low wetting angles, given the right flux.
- When brazing titanium to copper, the ZN22Al filler metal produced higher strength joints on average.
- When brazing titanium to stainless steel, the TiBraze-665 filler produces higher strength joints on average.
- While strong joints were produced, the joints had porosity; capillary rings were able to improve joint density but had little effect on joint strength.

Future Work

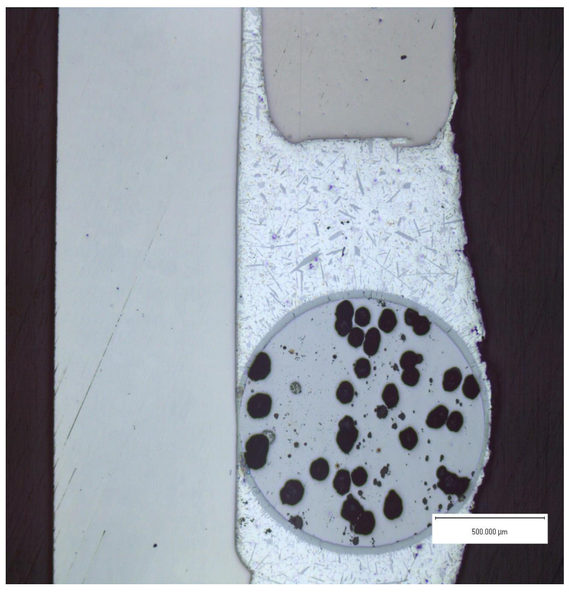
- Research the composition of intermetallics formed
- This may explain why joints with higher density were no stronger than porous joints
- Further analyze the strength of joints for higher sample size and eliminate geometric issues as a factor

Results & Discussion

- Overall, the strongest joints were titanium to copper brazed with Zn22Al filler and titanium brazed to stainless steel with TiBraze-655 filler
- Capillary rings greatly improved joint density



A titanium to stainless steel joint cross-section, slight porosity can be seen along top edge of fillet



A titanium to stainless steel joint with a capilary ring, porosity in braze material is virtually eliminates, black spots in steel ring are an etching artifact.

A titanium to stainless steel brazed connection made with TiBraze-655 filler, titanium is on the inside and steel outside.

A titanium to copper brazed part with Zn22Al braze material, fillet is fully formed and connection is air-tight