SAND2020-0273D

Brazing Additively Manufactured Metal

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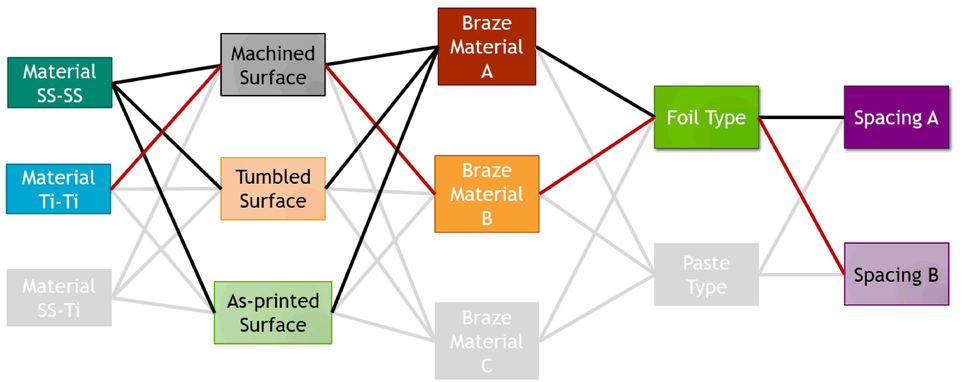
Brazing as a joining method has a well established foundation. This explores the use of brazing for additively manufactured metal parts

Hypothesis and Motivation

- Investigate the feasibility and strength of using brazing as a joining method for additively manufactured part
- This study came from the need to have a single part, which was designed using topology optimization (TO), printed in sections and then joined together
- Why not weld?
  - The two parts, with a large surface area at the joint, needed to be joined in such a way as to not invalidate the TO design. This meant joining across the entire cross sectional area of the joint
  - Seem welding around the perimeter would have resulted in the center of the cross sectional area being disjointed
- What strength can we achieve with brazing two faces together? What effect, if any, does surface finish have on the joint?



4 different combinations were tested, concentrating on surface finish, with 4-6 samples each for a total of 21 samples

Experimental Details

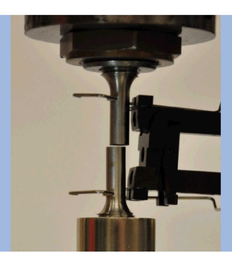
- Several variables were identified as part of this study:
  - Base material:
    - Stainless steel to stainless steel
    - Titanium to titanium
    - Stainless steel to titanium
  - Brazing Material:
    - Several different brazing alloys are available
  - Brazing material type:
    - Paste type
    - Foil type
  - Surface Finish:
    - Machined finish
    - Tumbled polish
    - As-printed finish
  - Brazing alloy spacing:
    - Optimal spacing between parts was unknown

6	316 SS to 316 SS	As-printed	Gold Nickle alloy (BAu-4)	Foil
6	316 SS to 316 SS	Machined	Gold Nickle alloy (BAu-4)	Foil
5	316 SS to 316 SS	Tumble polished	Gold Nickle alloy (BAu-4)	Foil
4	Ti6Al4V to Ti6Al4V	Machined	Ti20Zr20Cu20Ni (TiBraze)	Foil

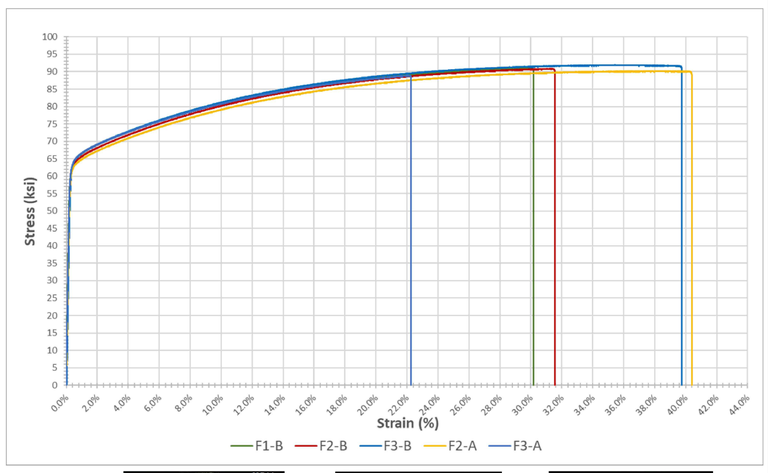
Failed in brazing process, did not proceed to tension testing

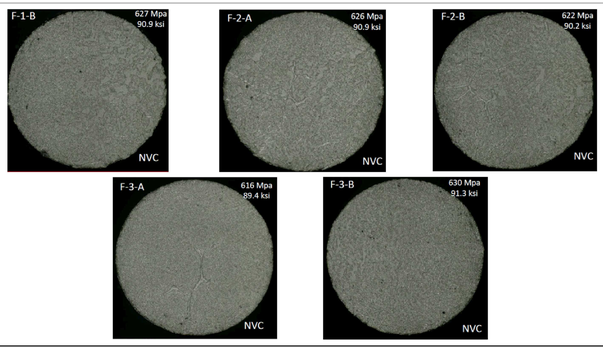
Results

- The surface finish has a large effect on the overall quality of the braze.
- As-printed did braze, and with more investigation into optimal parameters, could yield satisfactory results
- Titanium to titanium could yield satisfactory results given enough time to find the optimal perimeter set
- This work showed the feasibility of using brazing for joining AM metals

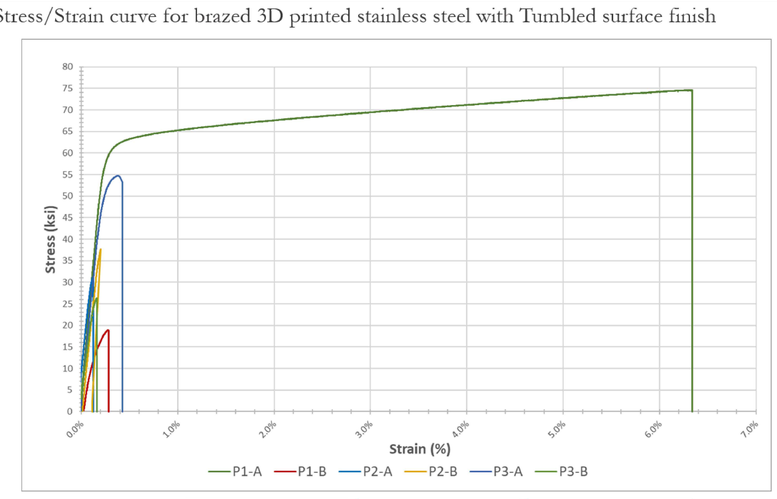


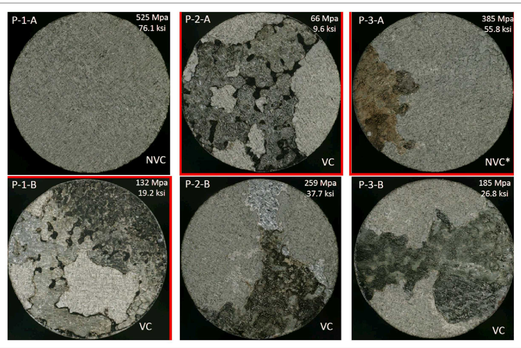
Stress/Strain curve for brazed 3D printed stainless steel with machined surface finish



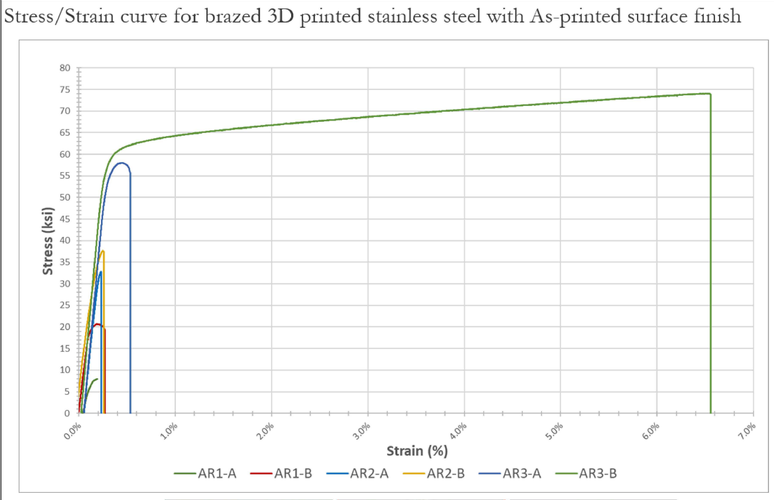


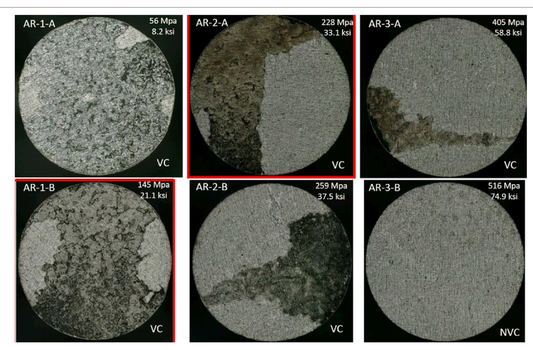
Stress/Strain curve for brazed 3D printed stainless steel with Tumbled surface finish



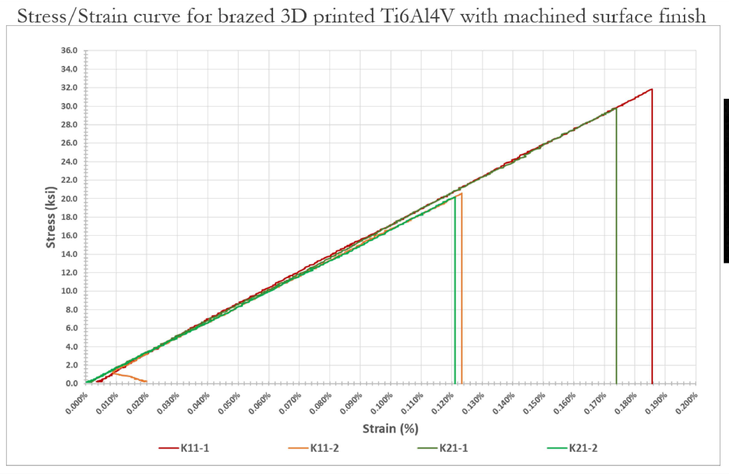


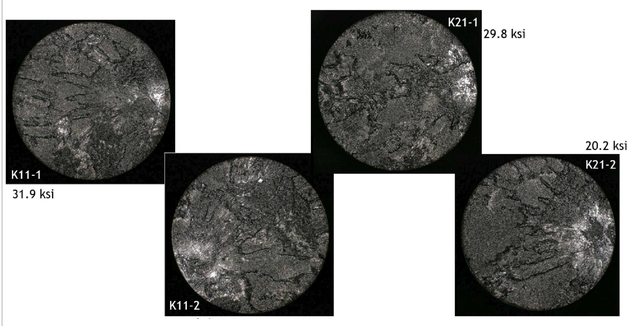
Stress/Strain curve for brazed 3D printed stainless steel with As-printed surface finish





Stress/Strain curve for brazed 3D printed Ti6Al4V with machined surface finish





Future Work

- Subsequent work would explore the alternate variables that were passed over on this study, with a concentration on:
  - Joining dissimilar AM metals
  - Investigate relationship with surface finish and brazing filler thickness
  - Finding optimal parameter sets for the given base AM metal and brazing alloy combination
  - Improving the strength of the brazed joint through these various parameters
- Investigate the dimensional accuracy of the process on large parts

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