Air Braze Optimization for Markets Targeted by Aegis Technology, Inc.

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Pacific Northwest NATIONAL LABORATORY
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OBJECTIVES

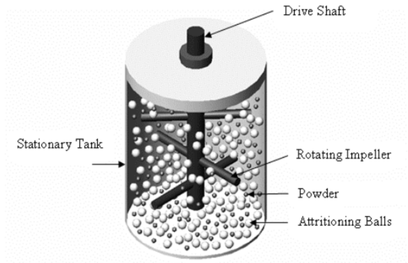
This work will help Aegis Technology, Inc. evaluate the commercial value in their target markets of the air braze developed by PNNL by:

- Optimizing fabrication processes for commercial-scale air braze production in marketable forms.
- Characterizing the mechanical integrity and hermeticity of air braze joints at elevated temperatures and in corrosive environments.

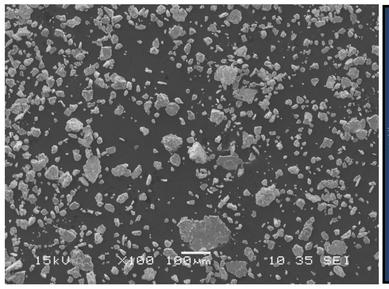
CRYOMILLED POWDERS

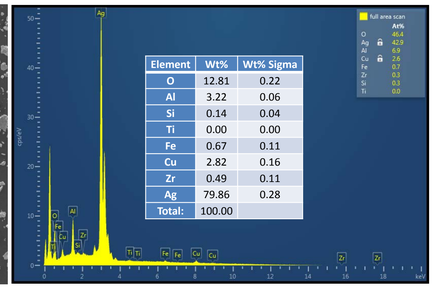
Air braze powders were cryomilled by Aegis

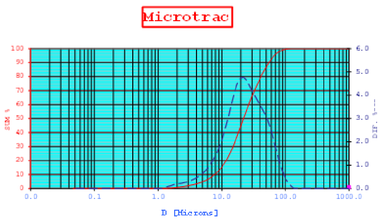
- Small-scale attritor (1 pound powder).
- 0.250 in. YSZ ceramic ball media
- 30:1 Ball media to powder
- Performed at around -165°C for 8-12hrs
- Powder fractures into sub-micron or nano-sized particles and then cold-weld into coarser agglomerates.
- Results in well mixed nano-crystalline powders



Powders were then characterized by PNNL







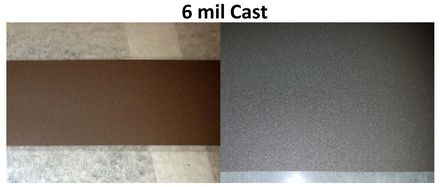
After Cryomilling

- Powder composition consists of Ag, Cu, Al, O as expected with traces of Fe, Si, and Zr
- Particle size ranges from 1 to over 100 µm with average size ~10-20 µm

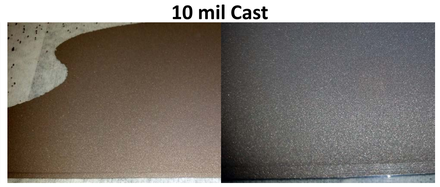
AIR BRAZE TAPES

Slurry batches were formulated and tapes were cast by PNNL

6 mil Cast



10 mil Cast



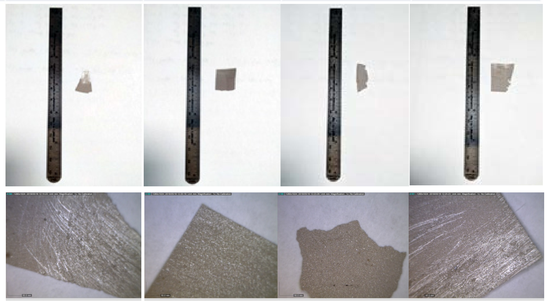
	First Cast	Second Cast
Cast Thickness	6 mils	10 mils
Green Thickness	75 µm	120 µm

- First tape was not strong enough and tore easily
- Slight decreases in solids loading were made for second tape
- Second tape did not stretch or tear
- Additional tapes were cast at 20 and 30 mils thick
- Could likely cast tapes as thick as 50 mils

ANNEALING TAPES TO FORM FOILS

- Tapes were annealed to form foils by Aegis at 700, 750, and 800°C for 30, 45, and 60 min. in air or Argon.
- Quality checks include optical inspections, basic handling, sanding, and bend testing.
- Best conditions to date were found to be 750°C for 30 min in air with the 270um thick tapes.

Thickness	270 µm	122 µm	152 µm	150-165 µm
Annealed in air	Best	OK	Marginal	OK
Annealed in Ar	Not good, easily broken	Not good, easily broken	Not good, easily broken	Not good, easily broken

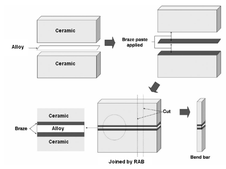


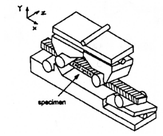
Will continue efforts to identify optimal annealing conditions by annealing at different temperatures and times

FUTURE PLANS

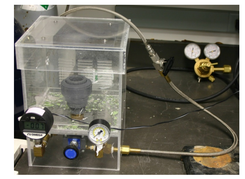
The future work of this development effort include:

- Characterize the mechanical strength (e.g. 4-point bend) of joints made with air braze alloy foil at elevated temperature (e.g. 750°C in air). The mechanical strength should be within 75% of previously published data at a comparable composition, or as necessary for commercial utilization.





- Characterize hermeticity (e.g. pop-gun testing) of joints made with air braze alloy foil after reducing/corrosive environment exposure (e.g. 750°C in hydrogen). Joints made using air braze alloy should retain hermeticity after exposure to corrosive environments.



- Commercialization and market research of this high-temperature sealing technology for use in gas separation devices and solid oxide fuel cells (SOFCs).

SUMMARY

- In this work we have shown our progress towards optimization of air braze technology for commercial scale production.
- To date we have developed methods to cryomill powders to produce air braze alloys.
- The resulting powders can be cast into tapes.
- The tapes can be annealed in air to form foils.
- Work continues to develop thicker cast tapes and foils.
- Future work will include evaluating both mechanical strength and hermeticity of joints made with these air braze foils after exposure to high temperatures in air and hydrogen.
- In addition, Aegis Technologies will conduct market studies.

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