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Wetting and Reactive Air Brazing of BSCF for Oxygen Separation Devices

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Background

- Integrated gasification combined cycle (IGCC) is used to facilitate high-efficiency carbon capture. IGCC need a supply of high-purity oxygen in order to efficiently generate carbon dioxide and minimize the emission of other gases
- Mixed ionic/electronic conducting (MIEC) ceramic membranes catalyze the dissociation of oxygen from air on one side and transport it across a chemical gradient to the other side.
- MIEC systems are responsible for a 2-5% efficiency loss. Other systems such as cryogenic separation of air is more energy intensive and has more than a 10% efficiency loss.
- $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{(3-\delta)}$ (BSCF) was determined to be the highest potential MIEC material based on the design and oxygen flux requirements of an oxy-fuel plant.
- Ceramic joining is difficult and most ductile metals do not wet most ceramics. Reactive air brazing (RAB) with Ag-Me_xO_y systems have been used.

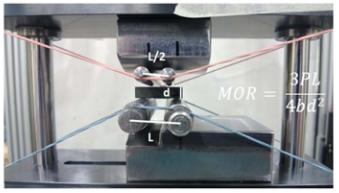
Goal

- Develop a RAB alloy and process for joining BSCF.
- Develop a fundamental understanding of the wettability and microstructural development due to reaction kinetics in BSCF/Ag-Me_xO_y systems.
- Success will be defined as the braze joint being hermetically sealed and the joint having greater than 50% of the flexural strength of monolithic BSCF.

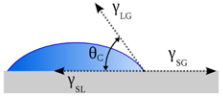
Results

Monolithic Testing

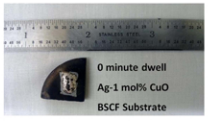
- A fully articulated four point bend flexural test fixture was designed (ASTM C1161).
- Monolithic BSCF samples were tested to determine baseline flexural strength.
- MOR for monolithic BSCF was 95 ± 33 MPa.

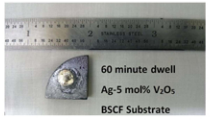


Wettability

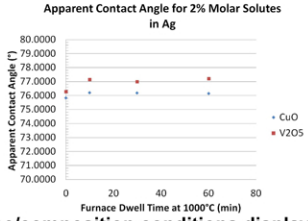


- 1, 2, and 5 molar percent compositions of CuO and V_2O_5 in Ag were tested on BSCF substrates.
- Furnace runs were performed to 1000°C with dwell times of 0, 10, 30, and 60 minutes. The furnace would ramp and cool down at 33.3°C/min. The varying dwell times were used to attempt to control the reaction kinetics.





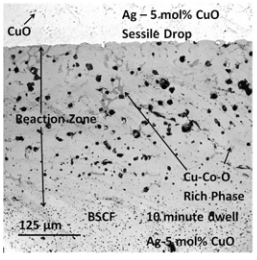
- Apparent contact angle was calculated for all time/composition conditions.

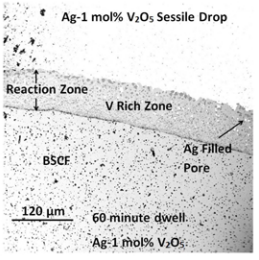


- All time/composition conditions displayed wetting behavior with apparent contact angles between 74° and 78°.

Reaction Product Layer

- All results are preliminary. SEM and EDAX analysis continues for compostion/time conditions.
- Ag-CuO interfacial microstructures exhibited dissolution of copper oxide into the BSCF matrix to form copper-cobalt-oxygen rich dissolution products (Joshi, J Mater Sci (2013)).
- Ag-V_2O_5 interfacial microstructures revealed the formation of a reaction product layer with cobalt and iron being replaced by vanadium with silver filling pores in the BSCF microstructure.





Future Work

- Based on these results, brazes will be fabricated and mechanically tested to begin to optimize the brazing parameters for this system.

Acknowledgments

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