Investigation of Cu - Based Perovskites Properties as OTM's

Judi Al Chekha, Citrus College
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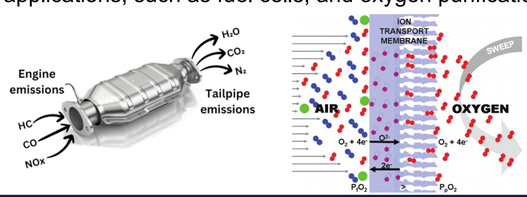
Background

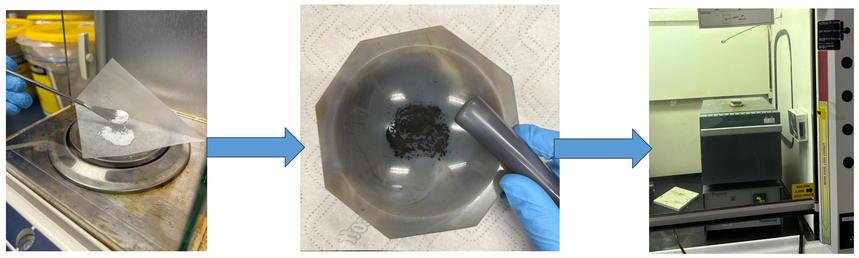
- Oxygen transport membranes (OTMs) are a type of membrane that allows for the selective transport of oxygen ions through a solid material.
- Perovskites, which generally conform to the formula ABX_3, possess oxygen vacancies that facilitate oxygen diffusion, making them suitable for use in OTMs.
- When integrated with perovskites, these membranes can facilitate the efficient movement of oxygen, which is crucial in various industrial processes.
- OTMs are useful as they offer a combination of high oxygen permeability, selectivity, and stability under operating conditions. This makes them suitable for various applications, such as fuel cells, and oxygen purification.



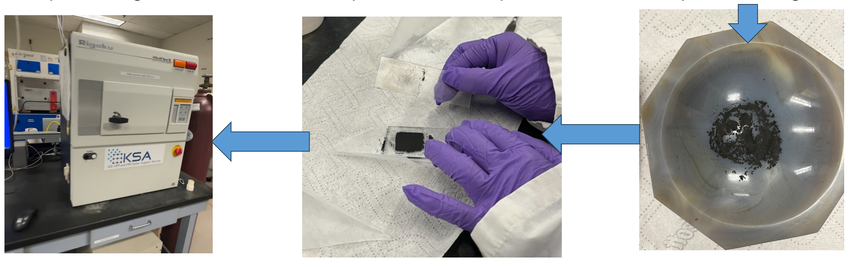
Hypothesis

Are copper compounds as layered perovskites useful as oxygen transport membranes?

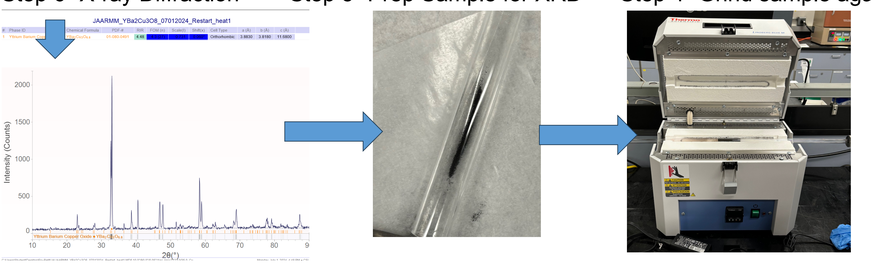
Methods



Step 1- Weigh out chemicals | Step 2- Grind sample for 30 min. | Step 3- Heating of sample



Step 6- X-ray Diffraction | Step 5- Prep Sample for XRD | Step 4- Grind sample again



Step 7- Run sample through JADE | Step 8- Prep for Gas boarding | Step 9- Gas board sample

Results

JAARMM_YBa2Cu3O8_07012024_Restart_heat1

#	Phase ID	Chemical Formula	PDF-#	RIR	FOM (n)	Scale(I)	Shift(x)	Cell Type	a (Å)	b (Å)	c (Å)
1	Yttrium Barium Copper Oxide	$YBa_2Cu_3O_{6.8}$	01-080-0491	4.48	4.3(22)	0.731	0.065	Orthorhombic	3.8830	3.8180	11.6800

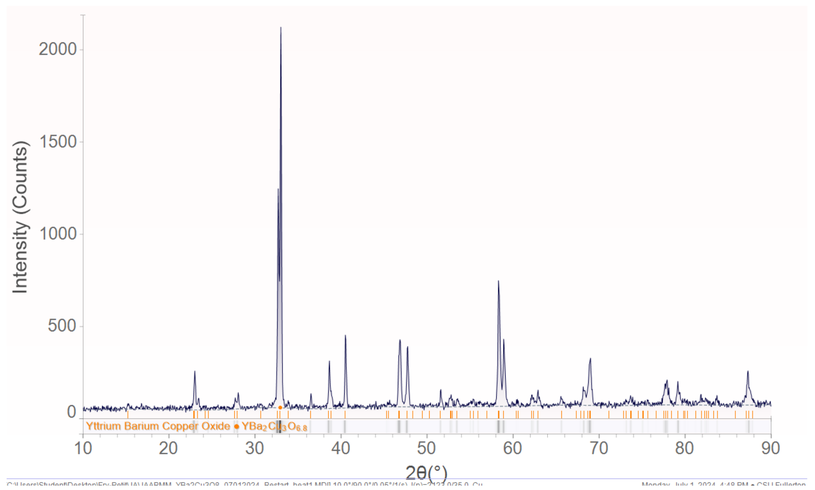


Figure 1- JADE file showcasing the pure $YBa_2Cu_3O_8$ sample following the first heating trial of the second batch.

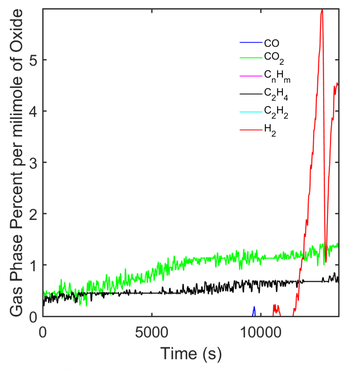


Figure 2- Graph of gas board data displaying $YBa_2Cu_3O_8$ TPR, giving insight of temp at which reduction occurs, 1070 °C

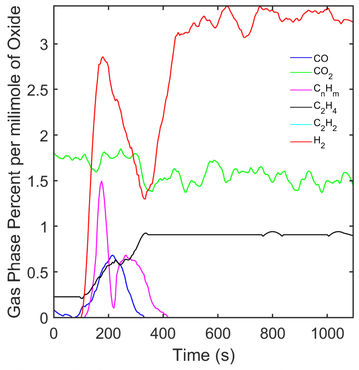


Figure 3- Graph of gas board data displaying $YBa_2Cu_3O_8$ first reduction, which gives insight of what products are formed.

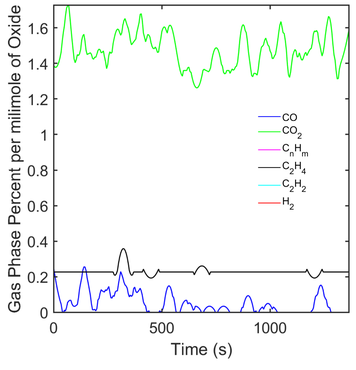


Figure 4- Graph of gas board data displaying $YBa_2Cu_3O_8$ first oxidation typically signifying organics coming off of the sample.

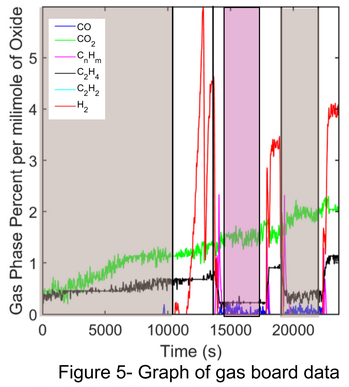


Figure 5- Graph of gas board data displaying $YBa_2Cu_3O_8$ cycle, showing the performance of our sample.
- White- Reduction CH_4 mix
- Beige- Oxidation
- Pink- N_2 purge

Conclusion

- The optimal heating conditions for the copper samples were determined to be at 920 °C for 24 hours.
- Sample originally melted at 950 °C, therefore a second batch was made. Concluding the melting point of $YBa_2Cu_3O_8$ to be around 920- 950 °C.
- Copper sample melted in the gas board when being heated at 1070 °C.
- Due to $YBa_2Cu_3O_8$ sample being melted during gas boarding it couldn't undergo XRD.
- If $YBa_2Cu_3O_8$ was to go undergo XRD after gas boarding, we would've been provided with the phase composition and crystal structure.
- Gasboard analysis provided us knowledge of the oxidation and reduction cycle of $YBa_2Cu_3O_8$ similar to the phases they would as an OTM.
- Based on results indicating that $YBa_2Cu_3O_8$ isn't a solid following its melting point it doesn't have the ability to be useful as an oxygen transport membrane.

Future Work

- Synthesize new copper-based perovskite compositions to improve their stability, oxygen permeability, and mechanical properties.
- Study the thermal and phase stability of these perovskites at high temperatures to ensure long-term operation in practical applications.
- Develop composite membranes combining Cu-based perovskites with other materials to improve overall performance and stability.
- Collaborating with material scientists and chemists would improve approaches for accelerating the development and deployment of a wide range of materials. By working together, we can leverage our collective expertise to drive advancements and bring these materials to practical use more rapidly.

References

Schematic Representation of the Oxygen Transport Cascade. Physiological... | *Download Scientific Diagram*, www.researchgate.net/figure/Schematic-representation-of-the-oxygen-transport-cascade-Physiological-mechanisms-that_fig1_272518803. Accessed 2 Aug. 2024.

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Acknowledgements

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Petroleum Research Fund

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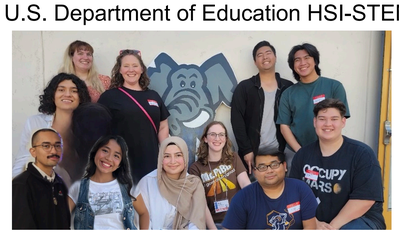

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