Molten Salt Screening for Electrically Enhanced CO_2 Splitting with Ceria

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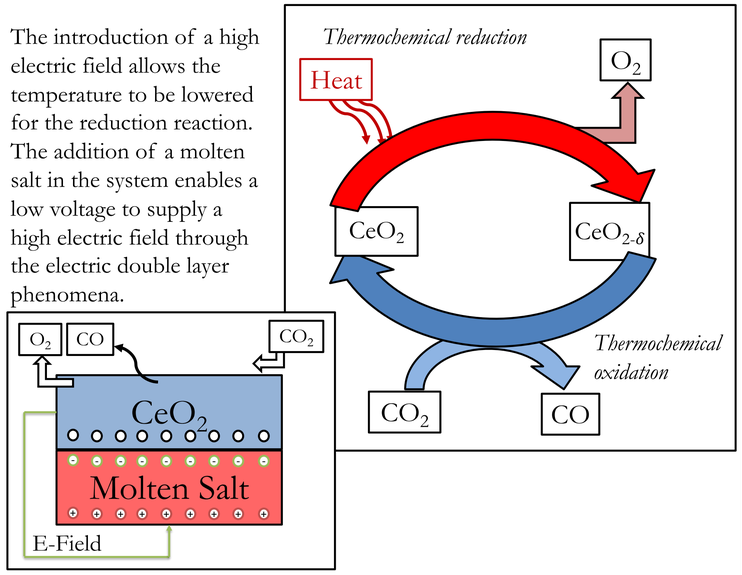
Thermochemical CO_2 Splitting

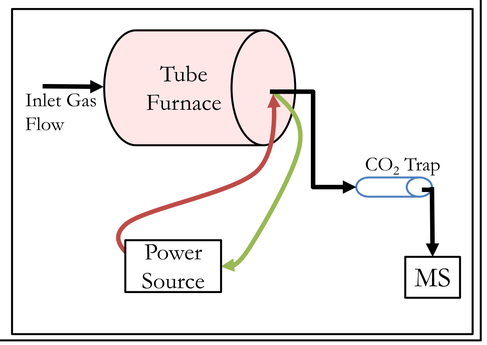
CO_2 is considered a greenhouse gas, and its emissions are thought to be linked closest to climate change. This has led scientists to investigate ways to reduce it to yield useful products. Ceria (CeO_2) can be used to split CO_2 in a two-step thermochemical process. Oxygen vacancies are formed in the ceria by endothermic reduction at high temperatures. CO_2 is used to oxidize the ceria, and the vacancies are filled by oxygen in the carbon dioxide, producing CO.

The introduction of a high electric field allows the temperature to be lowered for the reduction reaction. The addition of a molten salt in the system enables a low voltage to supply a high electric field through the electric double layer phenomena.

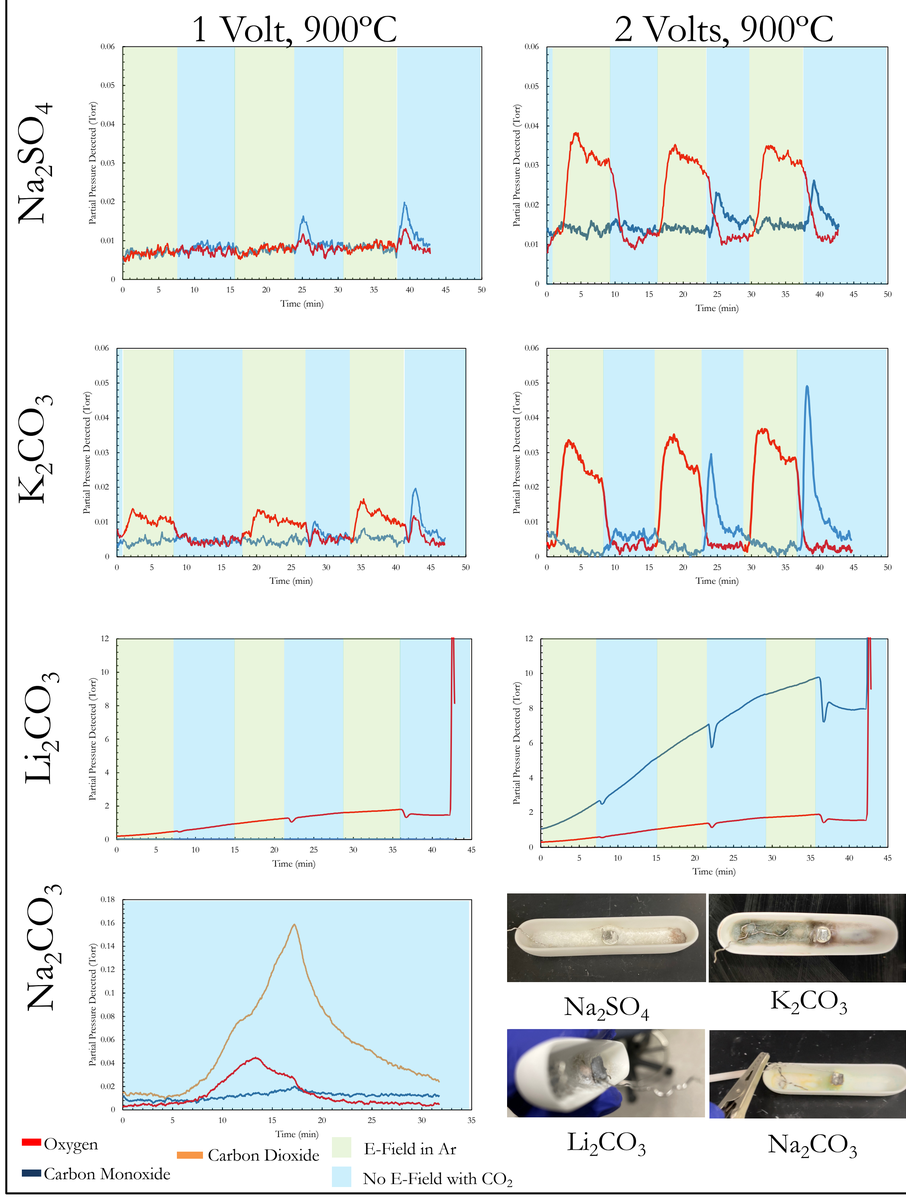


Methods

Gasses flow through a tube furnace at 900ºC. A power source is connected to a crucible, one end to a ceria pellet and one to a molten salt. For 10 minutes, an electric field is applied. The electric field is switched off and an impulse of CO_2 is supplied to the reactor. Outlets flow through a CO_2 trap and them to a mass spectrometer for analysis



Results



Discussion

	1 Volt		2 Volts	
	CO	O_2	CO	O_2
Na_2SO_4	Yes, small volume	No	Yes	Yes
K_2CO_3	Yes	Yes	Yes, large volume	Yes, large volume
Li_2CO_3	No	No	No	No
Na_2CO_3	Salt decomposed before reaction started			

K_2CO_3 was able to convert the highest volume of CO_2 to O_2 and CO.

Conclusion

Both lithium carbonate and sodium carbonate were unstable at the desired conditions of 900ºC. Sodium sulfate was able to split carbon dioxide to some extent, but it is limited because it needs a high electric field. Little evidence of oxygen and carbon monoxide was found with this salt at one volt. At two volts, the amount of carbon monoxide is still slightly lower than that produced by potassium carbonate. Potassium carbonate was able to produce carbon monoxide and oxygen at lower voltages as well as the highest volume at two volts.

Future Work

- Test more molten salts
- Higher and lower voltages
- Different temperatures

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