Bosch Process Technology Development for Air Revitalization

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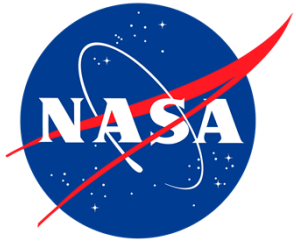
MSFC Jamboree Flash Talks



ECLSS & Air Revitalization

- Closed-loop ECLSS
  - *What you don't reclaim, you must resupply!*
- Reclaim O_2 from CO_2
  - CO_2 Removal
  - CO_2 Reduction
  - O_2 Generation

CO_2 Removal

- Sequester CO_2 from cabin air
- Pipe CO_2 to next process
- Return air to cabin
- Systems aboard ISS: CDRA, FBCO2, Collins Thermal Amines

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CO_2 Reduction

- Chemically reduce CO_2 into something more advantageous/useful
- Formerly aboard ISS: Collins Sabatier system
- Sabatier
  - $CO_2 + H_2 \leftrightarrow H_2O + CH_4$
- Bosch
  - $CO_2 + H_2 \leftrightarrow H_2O + C(s)$

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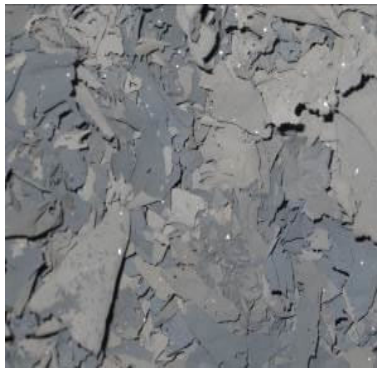
  - CO_2 Reduction
  - O_2 Generation

O_2 Generation

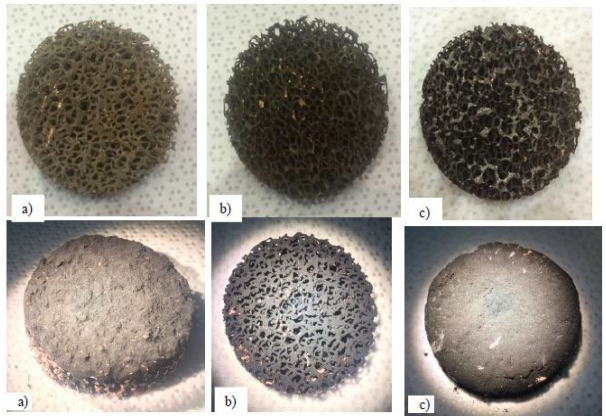
- Electrolyze the water into H_2 and O_2
- Mature technology
- Currently operating on ISS

The Bosch Process

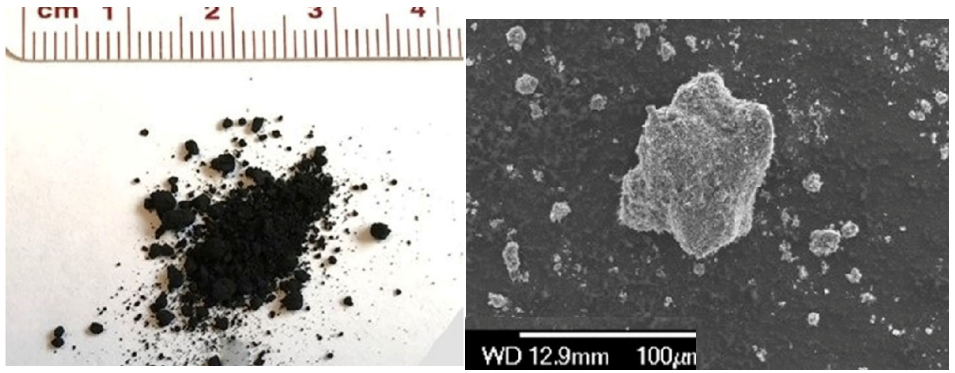
- $CO_2 + H_2 \leftrightarrow H_2O + C(s)$
  - Total O_2 and H_2 recovery
  - Fe, Ni, Co catalyst
  - 550-700 °C
- Solid carbon product
  - Fouls, degrades catalyst
  - Clogs and contaminates
  - Crew of 4 generates ~8 lbm of carbon per day!



Carbon formed in pH Matter CFR. Credit: Z. Greenwood, et al. 2018.



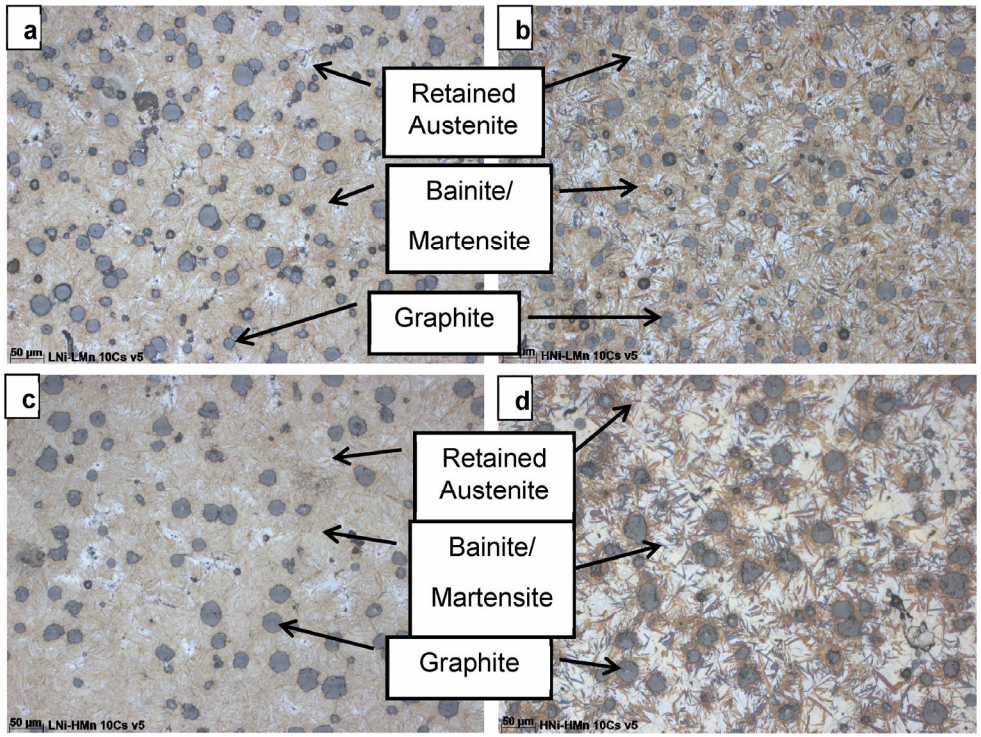
Bosch carbon formed on metal foam pucks. Credit: M. B. Abney, et al., 2016.



Bosch carbon from rotary kiln CFR. Credit: B. C. Stewart, et al. 2022.

ISRU and Future Work

- ISRU
  - Making steel with Bosch carbon + Martian regolith
  - Bricks, building materials
- ECLSS Future Work
  - Focus on carbon removal, containment via chemical and mechanical methods
  - Optimize process, reactors



Ductile/Nodular Iron samples manufactured by Mississippi State University using ionic liquid harvested iron simulant and Bosch Carbon. 10°C/s cooling rate. Credit: B. C. Stewart, et al. 2022.

Questions?

Thank you for your time!