Engineering nanoscale catalysts for clean hydrogen fuel production

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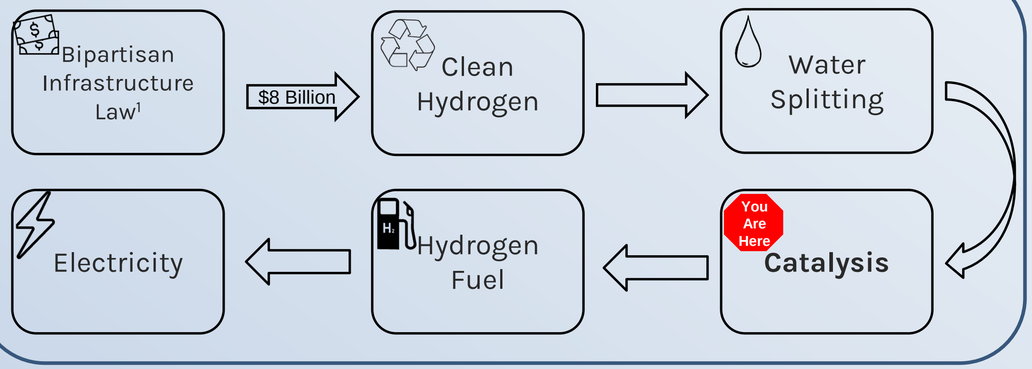
Richards Research Group: Ordinary to the Extraordinary

I. The Big Picture

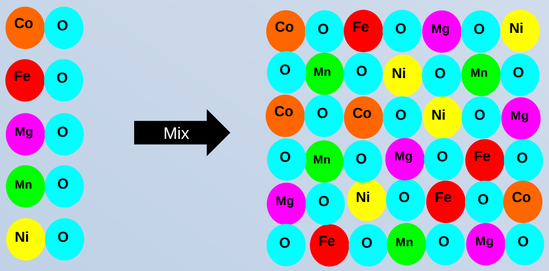


II. Background

- Water Splitting: Takes water and makes it into hydrogen and oxygen $H_2O \rightarrow H_2 + O_2$
- This process is inefficient. To increase the efficiency, a catalyst is used
- A catalyst increases the speed of a chemical reaction
- Common catalysts for water splitting include ruthenium oxide and iridium oxide (RuO_2 and IrO_2)[2]
- Ru and Ir are both expensive, rare, and precious metals
- Per oz they cost $475 and $4,800 respectively, the price of gold is $1,860[3]
- **Cheap and earth abundant water splitting catalyst are needed**

III. What This Group is Doing

- High-entropy metal oxides (**HEOs**)
- HEOs are composed of multiple metal elements in about equal proportions
- They have shown promise as a catalysis for water splitting because of their unique complex surfaces[4]
- A rock-salt structure (**RSS)** is a type of crystal structure
- We have a lot experience manipulating different RSS
- **Our Goal is to make HEOs from earth abundant metals (such as nickel, iron, and magnesium) that are in a RSS**



IV. Results So Far

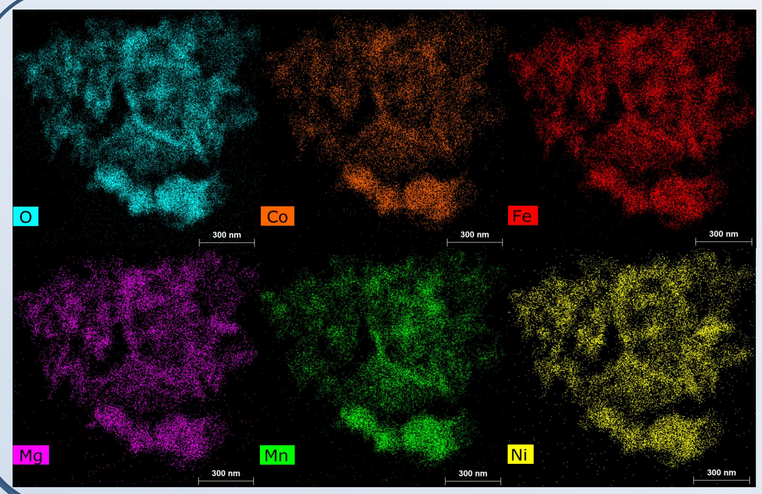
IV A. Overview

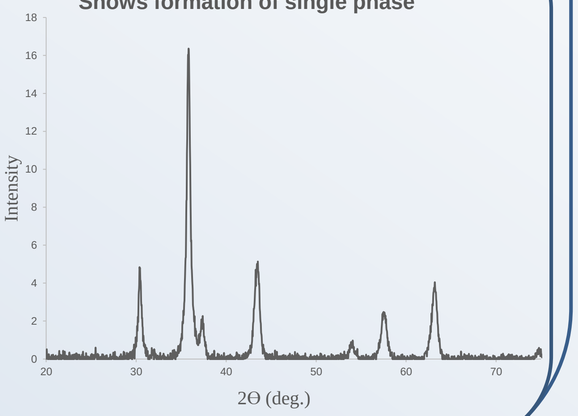
- We have made a HEO
- Just not with a RSS
- **Our Current Work is trying to make an HEO that has a RSS. This will allow us to manipulate the HEO and make it an even better catalysis**

IV B. Details

- The micrograph (left) suggest the elemental distribution of a HEO
- The graph (right) confirms a HEO distribution

IV C. Data





V. Acknowledgements

- The Ryan Richards Research Group
- The Colorado School of Mines
- The ARCS Foundation
- Project Bridge, PDA, and SACNAS

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VI. References

[1]https://www.energy.gov/articles/biden-harris-administration-announces-historic-7-billion-funding-opportunity-jump-start
[2] Yunjie Mei, Yuebin Feng, Chengxu Zhang, Yue Zhang, Qianglong Qi, and Jue Hu ACS Catalysis 2022 12 (17), 10808-10817
[3] https://pmm.umicore.com/en/prices/gold/
[4] Albedwawi, S. H.; AlJaberi, A.; Haidemenopoulos, G. N.; Polychronopoulou, K. High Entropy Oxides-Exploring a Paradigm of Promising Catalysts: A Review. *Materials & Design* **2021**, *202*, 109534.