Zn_2CuNi as Potential Hydrogen Evolution Reaction Electrocatalyst

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Introduction

Electrocatalytic water splitting has been investigated extensively for its potential to create clean energy by burning hydrogen and oxygen together to generate energy. The electrolysis of water can be split into two key reactions: the hydrogen evolution reaction (HER) and the oxygen evolution reaction (OER). Catalysts facilitate the breakdown of water into hydrogen and oxygen gas by lowering the overpotential of the two reactions involved in water electrolysis. The ideal reduction potential for OER is 1.23 V. However, due to the various kinetics involved in electrocatalysis, the actual value is higher than this theoretical value (overpotential). Reducing the overpotential is critical for improving the efficiency of electrolysis, allowing for faster and more cost-effective hydrogen and oxygen gas production. This project aims to investigate Zn_2CuNi as a good electrocatalyst with a low overpotential. As both an HER and OER catalyst, Zn_2CuNi has been calculated by our collaborators to be catalytically active for hydrogen and oxygen evolution. This will potentially offer a stable, inexpensive electrocatalyst that can efficiently break down water into hydrogen and oxygen gas.

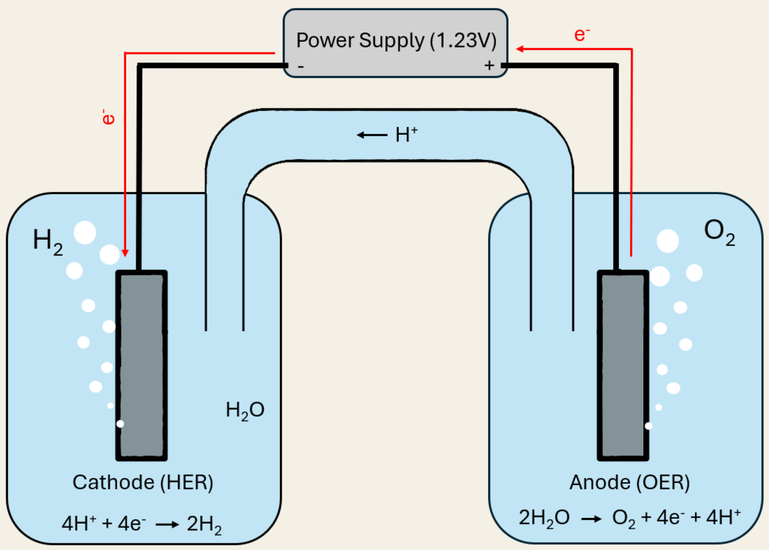
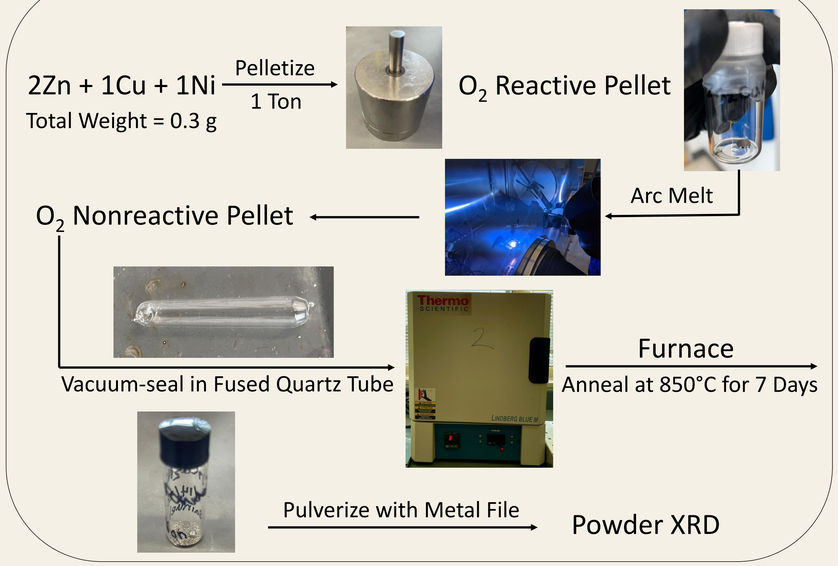


Figure 1: Electrolytic Cell

Materials & Methods



Crystal Structure

- Face centered cubic crystal structure
- XRD shows three peaks for the 111, 200, and 220 hkl planes (see Figure 2), confirming the purity of synthesized samples

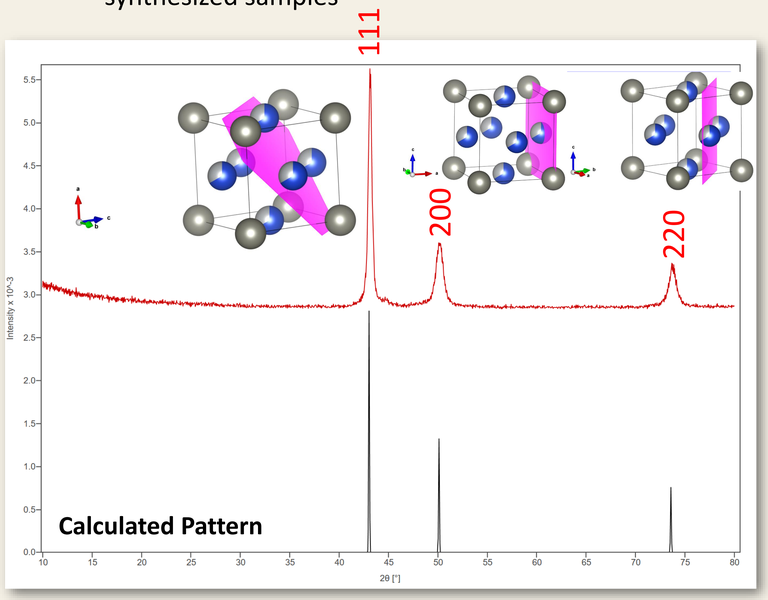


Figure 2: Zn_2CuNi Crystal Structure

Results

- Ball milling effectively reduces particle size in order to prepare catalyst
- Crystallinity is maintained post-ball milling, indicating this is a good candidate for OER/HER testing
- Sample is stable in 1 M HCl for 48 hours

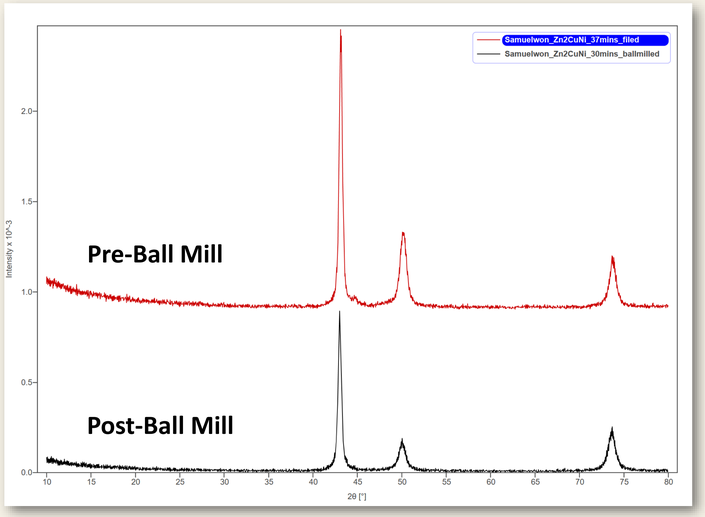


Figure 3: Powder X-ray Diffraction Graph

Future Directions

This project is not yet finalized as the overpotential of the Zn_2CuNi catalyst has not been measured. Once a large batch of Zn_2CuNi alloy is synthesized, the sample will be sent to Oakridge National Laboratory to have its overpotential tested. This HER/OER electrocatalyst will also undergo water electrolysis to test its catalytic performance and its long-term efficiency and stability.

References

Mann, D.; Xu, J.; Mordvinova, N.; Yannello, V.; Ziouani, Y.; González-Ballesteros, N.; Sousa, J.; Lebedev, O.; Kolen'ko, Y.; Shatruk, M. Electrocatalytic Water Oxidation over AlFe2B2. Chem. Sci 2019, 10 (9), 2796–2804.

van der Vegt, W.H.M.; van der Wegen, G.J.L.; Bronsveld, P.M.; de Hosson, J.T.M. Act. Cryst. A. (1981) 37, p. 101-101

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