4-1-2019

Almond Based Electrocatalyst for Fuel Cell Applications

Kinsey Morey
Pittsburg State University

Tucker Morey
Pittsburg State University

Brooks Neria
Pittsburg State University

Khamis Siam
Pittsburg State University

Pawan K. Kahol
Pittsburg State University

Almond based Electrocatalyst for Fuel Cell Applications

Kinsey Morey[1], Tucker Morey[1], Brooks Neria[1], K. Siam[1], P.K. Kahol[2], Ram K. Gupta[1,3]

Pittsburg State University, Pittsburg, Kansas

Background

- The rapid depletion of fossil fuels and growing environmental concerns have created an enormous worldwide demand for alternative clean energy technologies.
- Hydrogen has a potential to be one of the most effective clean energy sources due to its high energy density of 141.86 MJ/kg and clean combustion.
- Water electrolysis via photochemical and photoelectrochemical are the promising pathways for sustainable hydrogen production.
- The water splitting reaction can be expressed chemically as:

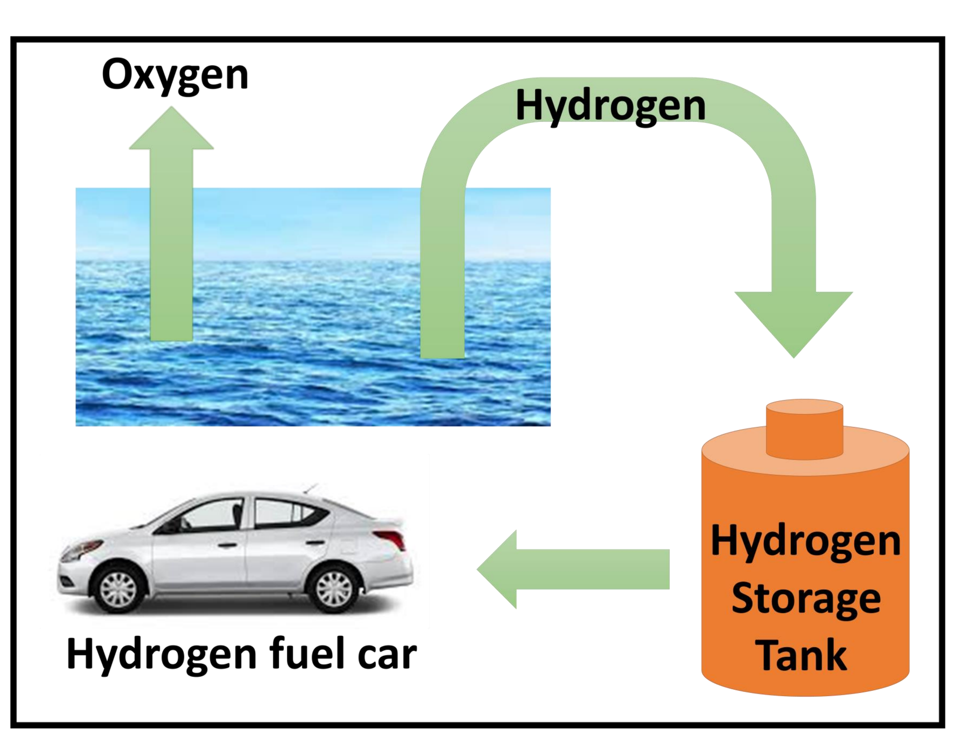
  Total reaction $2H_2O \rightarrow 2H_2 + O_2$ (1.23V)

Challenges

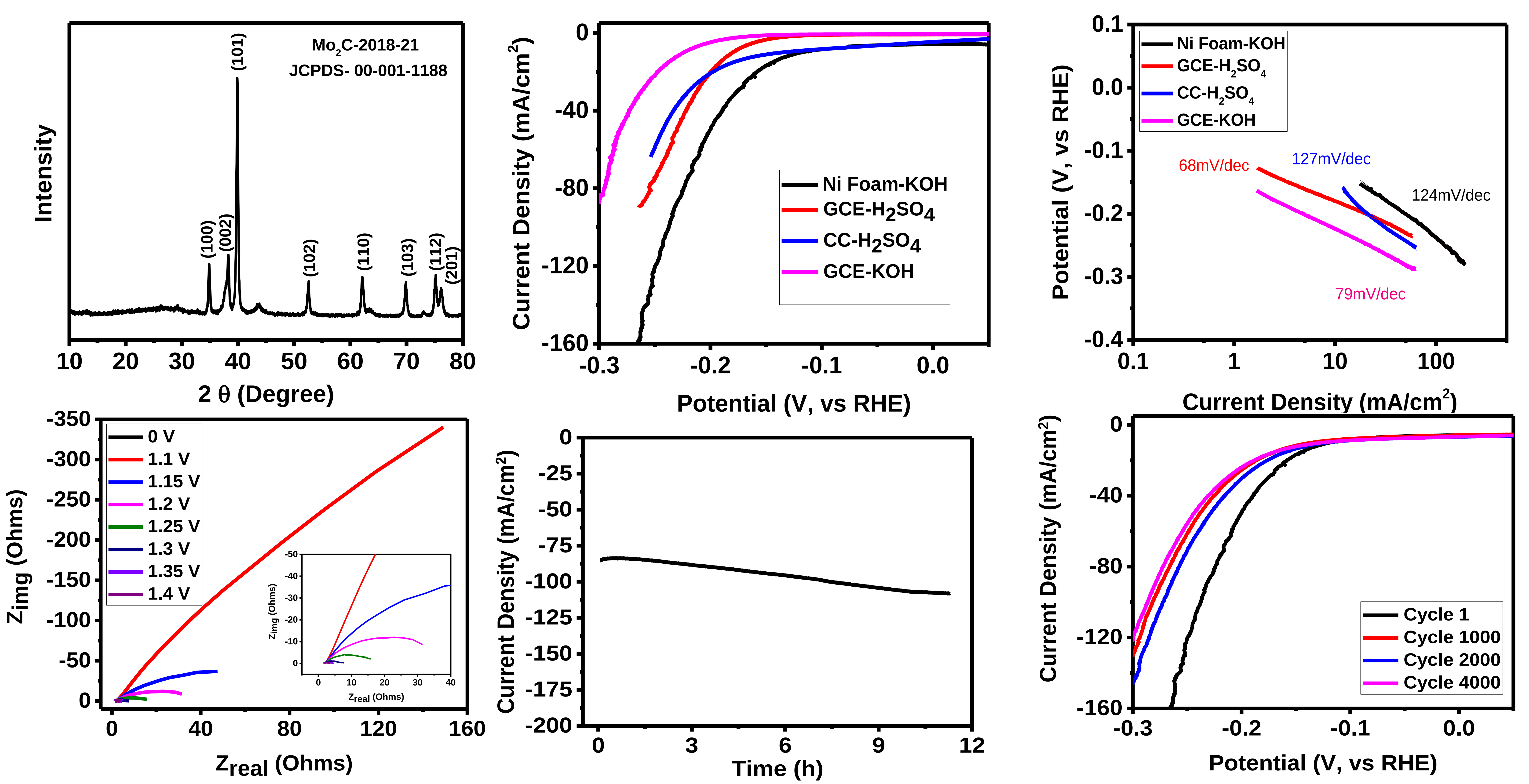
- Regardless of the media in which water splitting takes place, the thermodynamic voltage of water splitting is 1.23 V at 25 ºC and 1 atm. However, in fact, we must apply voltages higher than the thermodynamic potential (overpotential) value to achieve electrochemical water splitting.
- An ideal electro-catalyst should provide high current density at a lower overpotential.
- Platinum is one of the most efficient electro-catalyst for hydrogen evolution, however, its high cost and limited availability has curtailed its use for hydrogen production.

Solution through this research

- Replacement of Pt with inexpensive, earth-abundant electrocatalysts would be significantly beneficial for clean and efficient hydrogen evolution.
- We have used earth-abundant materials such as Mo_2C as an alternative to platinum electrocatalyst for hydrogen evolution.



Results and discussion



- We have prepared Mo_2C as a cost effective and biorenewable electrocatalyst capable of performing in both alkaline and acidic media.
- Mo_2C on nickel foam produces higher current densities (122 mA/cm² at -0.25 V) compared to the Mo_2C on GCE in acidic media (75 mA/cm² at -0.25 V) and Mo_2C on GCE in alkaline media (22 mA/cm2 at -0.25 V).
- Molybdenum carbide showed an overpotential of 117 mV and 180 mV in alkaline and acidic media, respectively to achieve a current density of 10 mA/cm2
- The long-term stability of the Mo_2C was studied using chronoamperometry and cyclic voltammetry measurements. The performance of Mo_2C is very stable up to about 12 hours of measurement.

Summary

- Mo_2C was synthesized using a facile method.
- The excellent electroactivity of Mo_2C is due to its high conductivity, high electroactive surface area, and pure phase structure.
- Mo_2C on nickel foam in basic media, Mo_2C on GCE in basic media and Mo_2C on GCE in acidic media showed Tafel slopes of 124, 79 and 68 mV per decade, respectively.
- Mo_2C could be a promising cheap electrocatalyst for hydrogen evolution reaction due to its high electroactivity and durability.

Future work & Acknowledgement

- We are working to develop multifunctional (energy storage and generation) materials using cost effective method.
- We plan to use other bio-waste materials for the synthesis of electrocatalysts.
- Sincere acknowledgement to the Polymer Chemistry Program, PSU and KINBRE (Grant # P20GM103418) for providing financial and research support.