Undergraduate Research Symposium
ADVANCING RESEARCH AND STEM FIELD ENGAGEMENT
PROJECT 6

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Immobilizing Molecular Water-Oxidation Catalysts on Carbon Nanoparticles

The continuous emission of greenhouse gases due to the rapid increase in the global energy demands is linked to climate change. This resulted in a general consensus that "climate change" is both real and worsening. Artificial photosynthesis (AP) is one of the most promising methods of reducing greenhouse gas emissions and combating climate change. To improve the AP process into a more practical use, there is a need to integrate the water-splitting reaction with the CO2 reduction reaction. Previous studies have mostly focused on designing homogeneous molecular catalysts for water splitting but few studies were done using heterogeneous composite materials that incorporate these catalysts. This research is focused on studying the immobilization of ruthenium complexes for water-oxidation (the half-reaction for water-splitting) on the surface of carbon for real utilization of the hybrid catalysts in a practical AP electrochemical device. Carbon has good electron conductivity, which provides a suitable platform for water-splitting catalyst immobilization. To help anchor the Ru (II) complex on the carbon electrode, graphite was functionalized with carboxylic acid groups (-COOH). The results of IR indicate the carboxylic group was incorporated into the carbon matrix. The catalyst was synthesized by sonicating G-COOH in a Ru(II) complex solution and soaking it overnight. The Ru catalyst was proven to be immobilized on the G-COOH electrode from Cyclic Voltammetry and UV/Visible studies. Further experiments are needed to improve the amount of Ru immobilized catalyst on carbon. The efficiency of the Ru catalyst for the water-oxidation reaction will be highlighted in this study.

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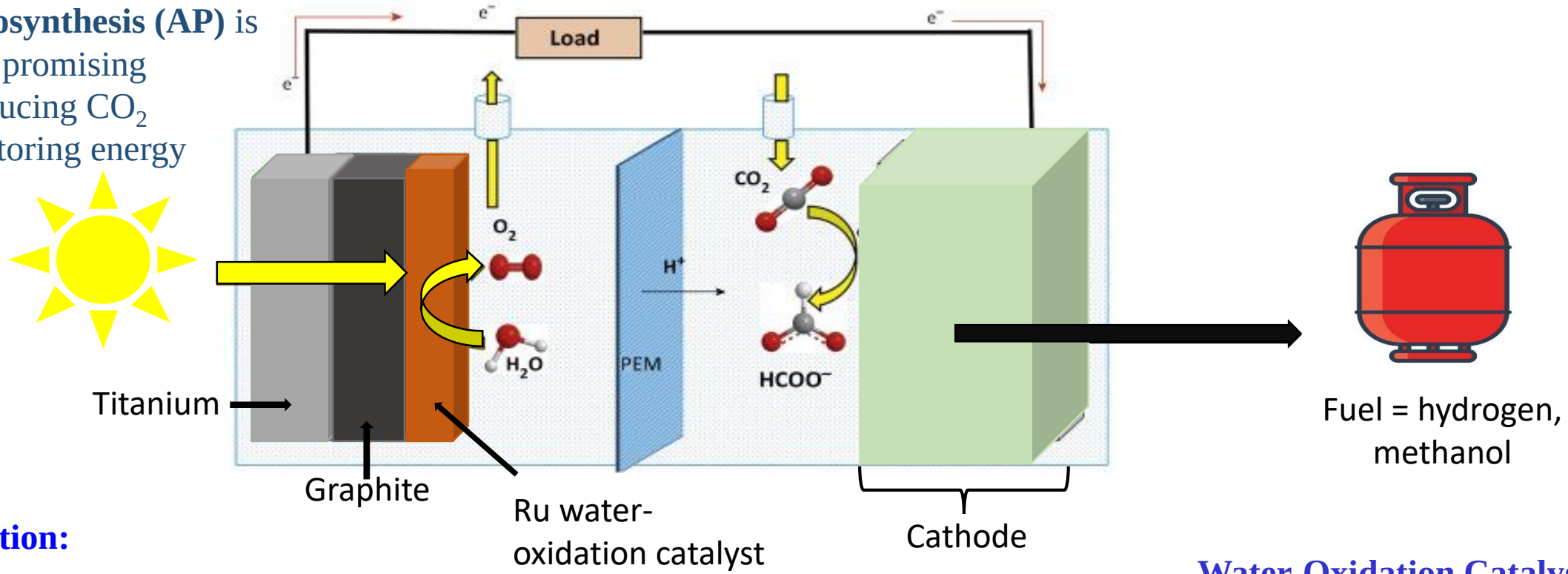
Immobilizing Water Oxidation Catalyst On Carbon Nanoparticles

- Claudio Amaya, Dr. Wanlu Li, Dr. Yosra Badiei*

Artificial Photosynthesis (AP) is one of the most promising methods for reducing CO_2 emissions and storing energy



Research Question:

- Can Ru water oxidation catalysts be immobilized on the surface of graphite?

Objective:

- Characterize and describe the interactions between graphite and Ru catalyst using electrochemical techniques and spectroscopic methods.

Water-Oxidation Catalyst

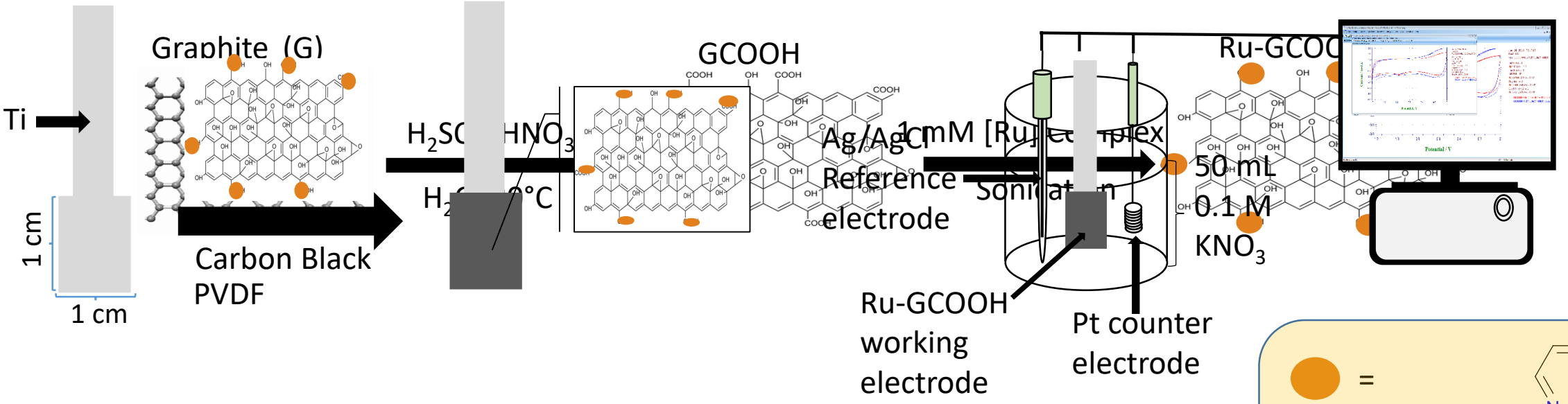
$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

Materials and Methods

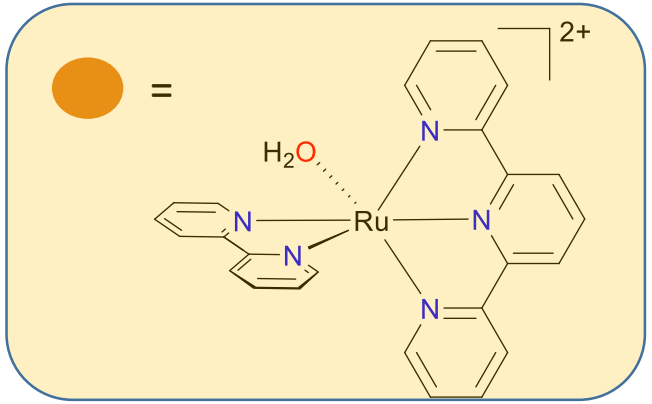
Synthesis of modified graphite followed by immobilization of Ru catalyst

Titanium Electrode

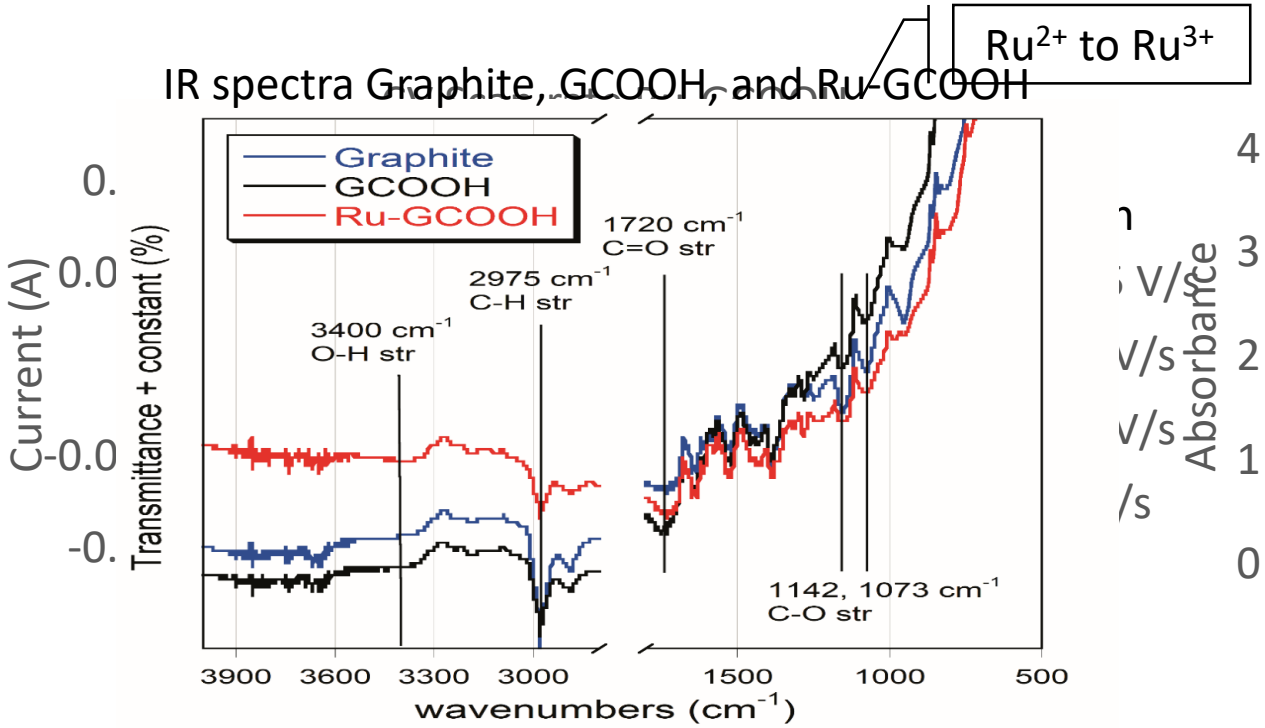
Instrumental Setup

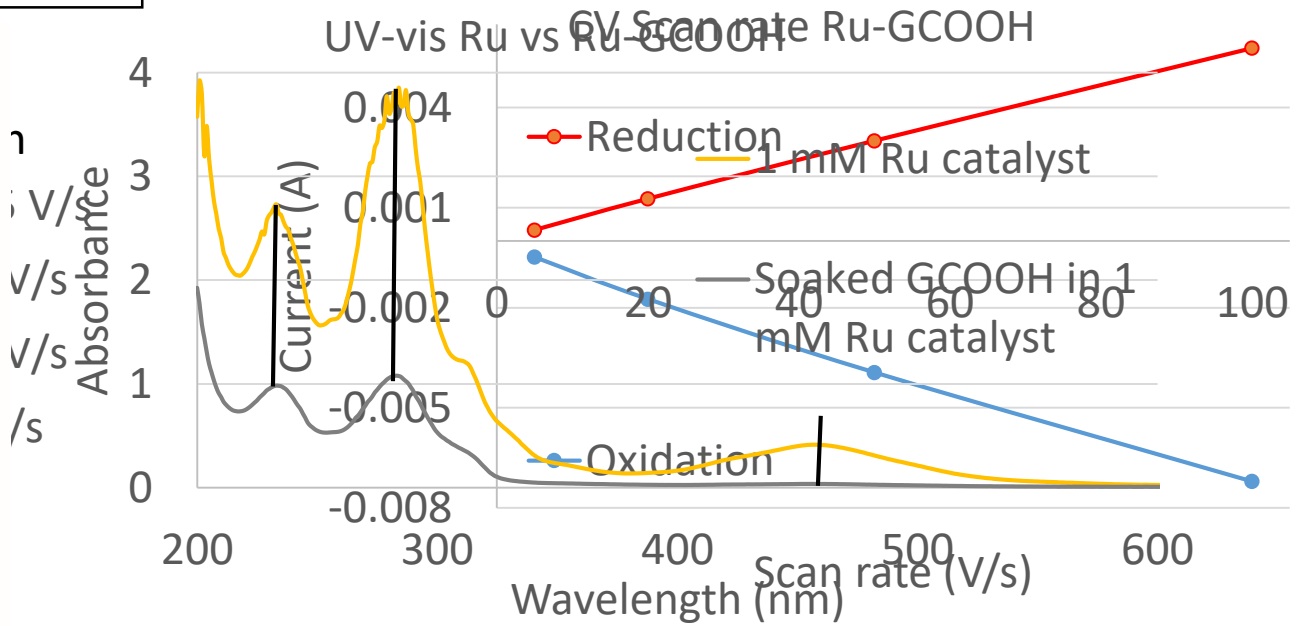


The orange circles represent the Ru water-oxidation catalyst $[Ru(tpy)(bpy)(H_2O)]^{2+}$
(tpy) = terpyridine ligand
(bpy) = 2,2'-bipyridine



Results





Wavelength peaks: 450 nm (visible), 290 (UV), 250 nm (UV)

Summary:

- Based on electrochemical data (cyclic voltammetry), IR and UV-Vis compelling evidence were obtained to show that the Ru water-oxidation catalyst was immobilized to the surface of modified graphite GCOOH.
- Future studies will focus on studying the electro-catalytic properties of the Ru-immobilized GCOOH.

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