Novel Approach to the Synthesis of Supported Gold Nanoparticles for HMF Oxidation

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Background

- Biomass-derived feedstock offers a sustainable solution for biodegradable plastics production.
- 2,5-furandicarboxylic acid (FDCA) is a key component, produced via 5-hydroxymethylfurfural (HMF) oxidation.
- Gold-based electrocatalysts show promise for enhancing HMF oxidation reactions (HMFOR) due to their low onset potential and robust stability.

Synthesis Method

- Step 1: Gold Oxidation
  - Potentialstat
  - Au Wire / Oxidized Au Wire (Au/C)

- Step 2: Gold Nanoparticle Synthesis
  - Potentialstat
  - Oxidized Au Wire / AuNPs

Results and Discussion

- Figure 5a: CV scan of Au/C (Au NPs on carbon) on fluorine tin-oxide (FTO) glass, revealing first observation of unique peak during the reverse sweep.
- Figure 5b and 5c: CV scans of the Au wire in alkaline media without HMF (5b), and with HMF (5c). A peak is also observed only in the reverse scan around 1.1V vs RHE, where oxidized gold is reduced.
- Figure 5d: CV scan of the Au wire with HMF conducted below the potential range for gold oxide formation, with no reverse peak observed.
- Figure 5e-f: Enhanced catalytic activity observed for Au/X in HMF oxidation (5e) and ethanol oxidation (5f).

Morphology Techniques

- Figure 4a-b: SEM images showing the surfaces of the oxidized gold wire and the synthesized Au/X with CV treatment, respectively.
- Figure 4c: SEM image of the Au/X wire without CV, highlighting the less uniformly distributed and rough, porous structure compared to 4b with CV.
- Figure 4d-e: HR-TEM images of the Au/X wire that display the formation of Au nanoparticles (Au NPs). The nature of surrounding film/layer (X) is under investigation.

Conclusion and Future Work

- Au/X layer significantly enhances oxidation processes in HMF and other reactants like EtOH, demonstrating the efficacy of gold as an electrocatalyst.
- A simple and reproducible method was established for synthesizing Au nanoparticles.
- Future work will focus on detailed characterization of the catalyst layer and its underlying mechanism by advanced spectroscopy and electrochemical analysis.

Acknowledgements

1. David and Lorraine Freed Undergraduate Research Symposium, Lehigh University
2. Clare Boothe Luce Research Scholars Program

References