Electrochemical analysis of Pt, Au and Cu surface alloys during hydrogen and CO_2 reactions in aqueous media

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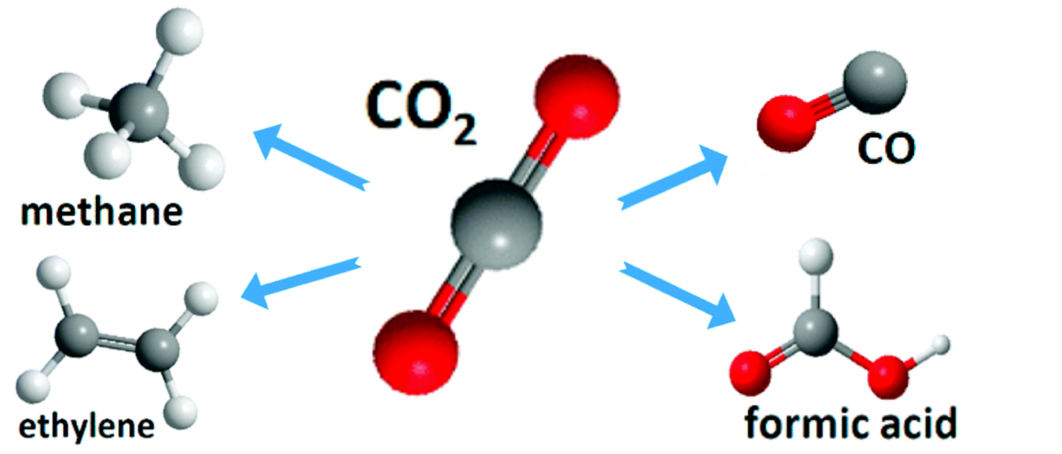
ABSTRACT: **Steady state electrochemical and spectroscopy measurements during proton and CO_2 reduction on Pt, Au, and Cu are reported for the improvement of HER and CO_2 reactions.**

- Hydrogen evolution reaction (HER) is the cathode half reaction of water electrolysis.
  - **HER ($2H^+ + 2e^- \rightarrow H_2$)** could be efficient on select surfaces (*e.g.* Pt) but is not efficient on more abundant transition metals.
- Reduction of CO_2 to CO or small hydrocarbons are also attractive for producing chemical fuels.
  - CO_2 reduction is slow and requires transfer of multiple electrons and protons.
  - $CO_2 + 2H^+ + 2e^- \rightarrow CO + H_2O$

INTRODUCTION:

- Heavy CO_2 emissions from burning fossil fuels has led to land degradation, ocean acidification, and climate change.[1,4]
- **Energy conversion** and **storage devices** in combination with existing clean sources of energy: solar power and wind energy.[2,3,5]
- HER and CO_2 reduction are great alternatives as they are clean and sustainable.[1,2,4]



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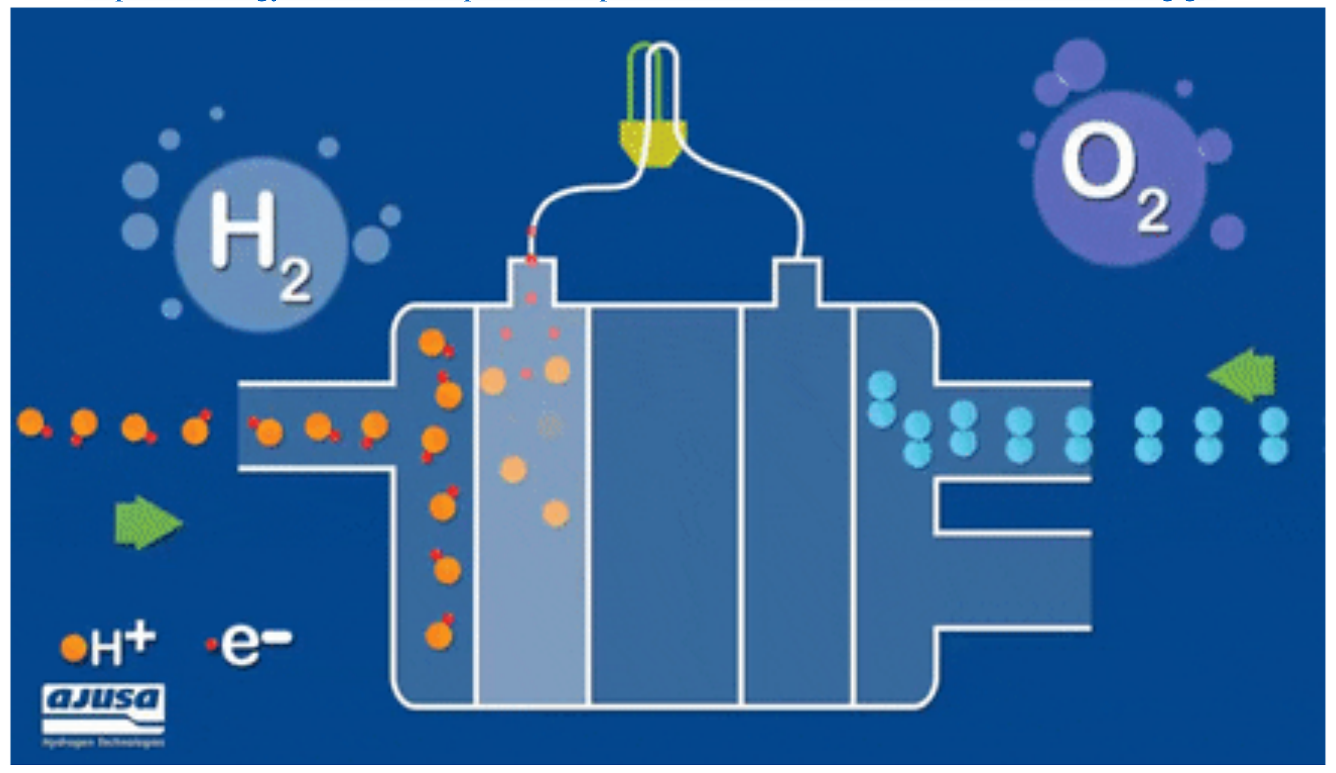

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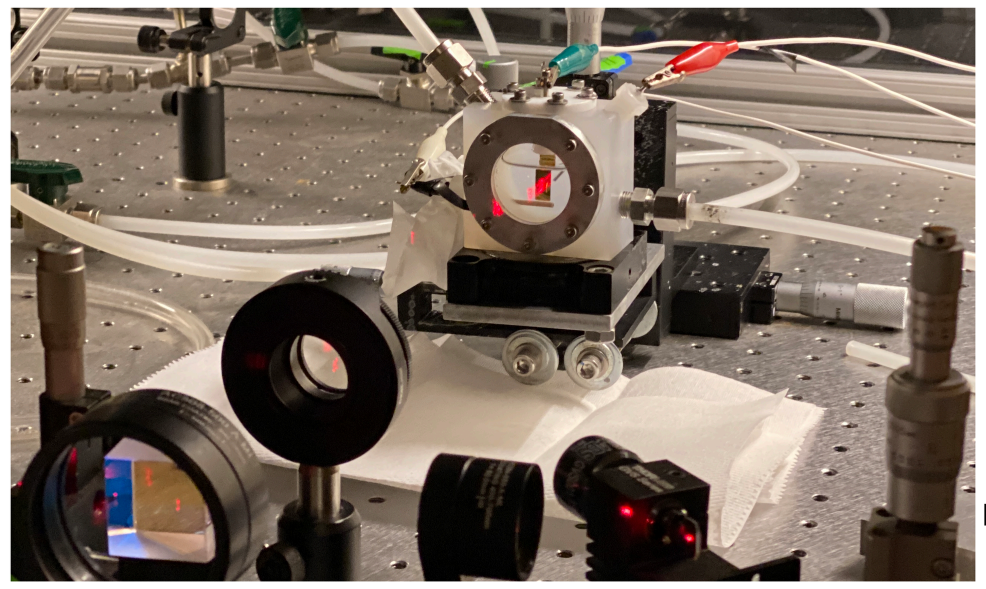
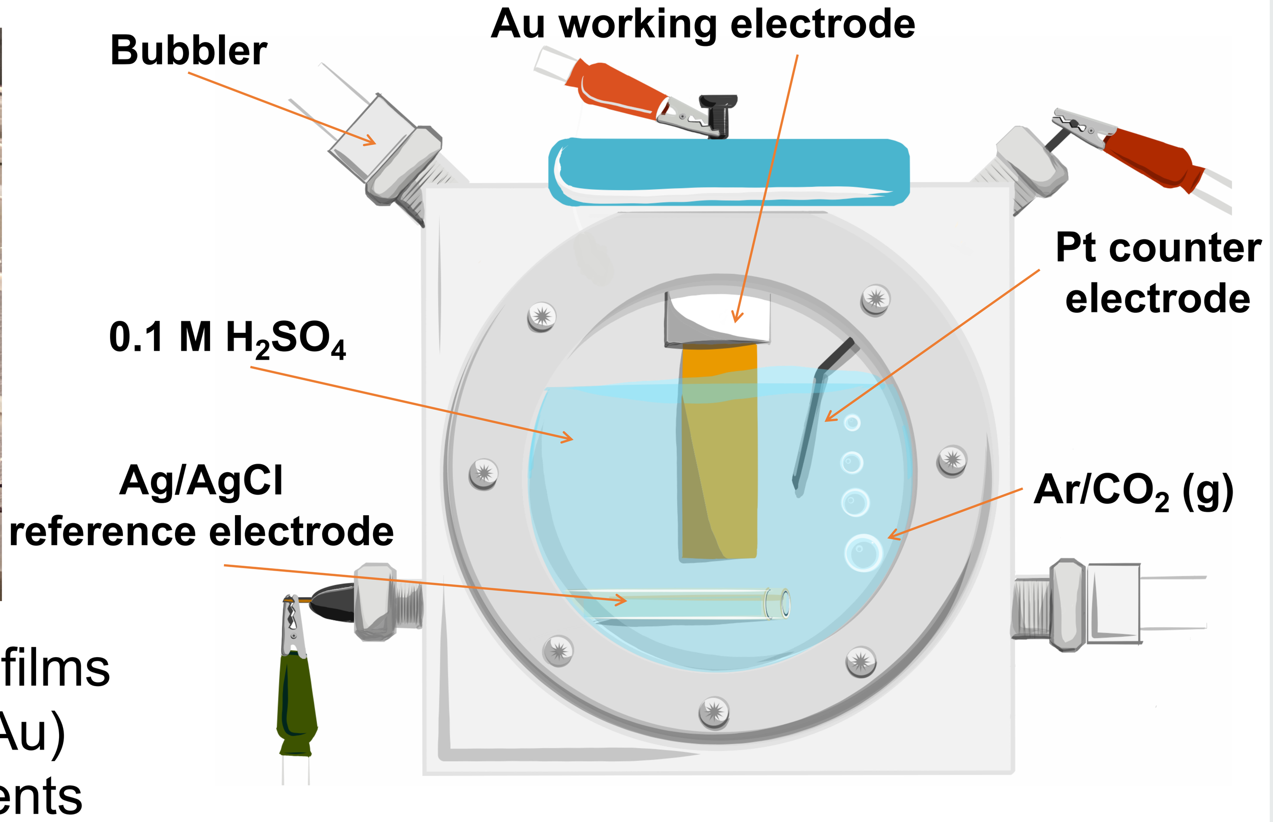
METHODS: Electrochemical Analysis





- Thermal evaporation to make Au thin films (10 nm Cr adhesion layer and 50 nm Au)
- Potentiostat and PSD related instruments

RESULTS: Cyclic Voltammetry and Stress

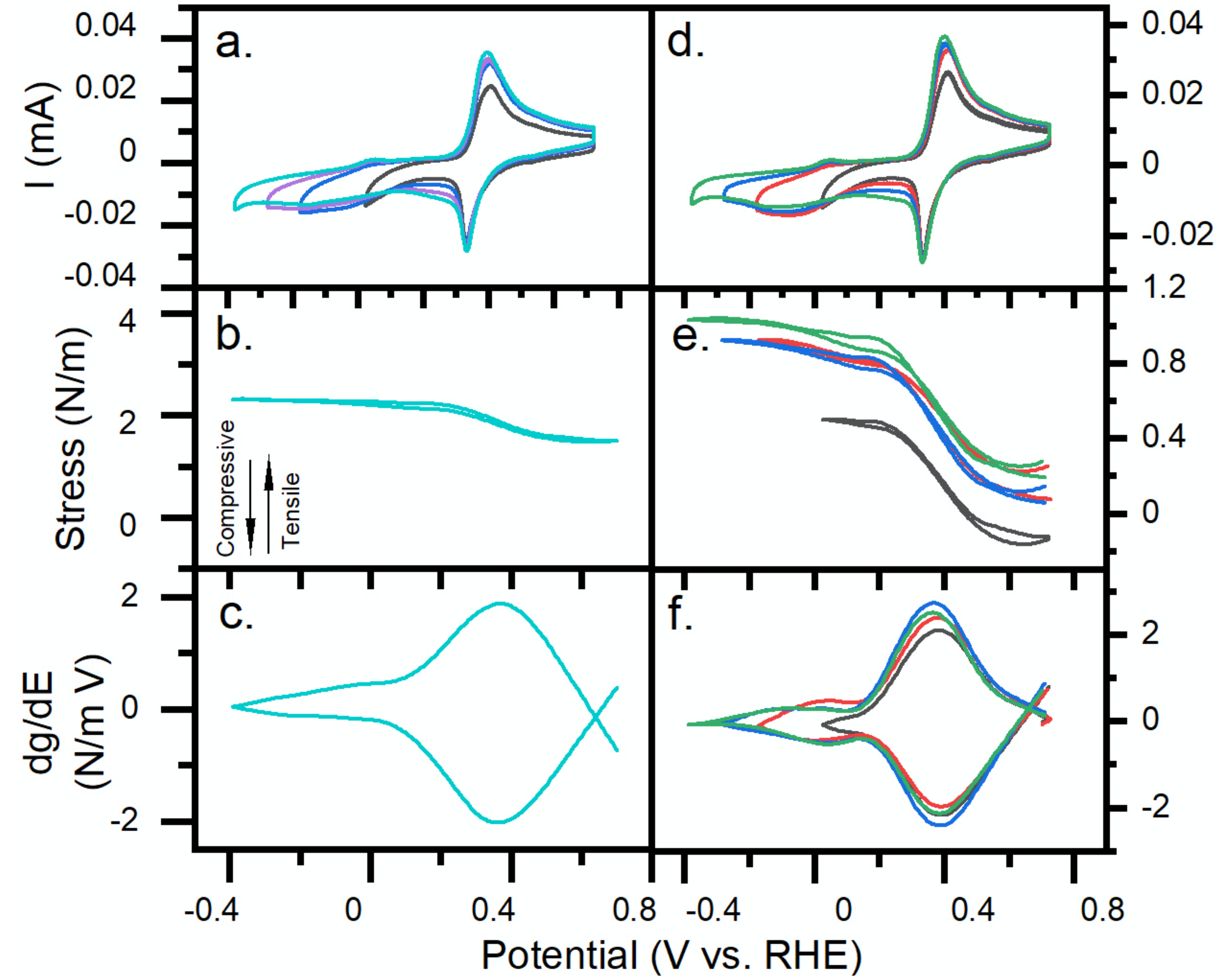


Figure 1. (a, d) Cyclic voltammogram (CV) of Au(III) in 0.1 M H_2SO_4 in the 0.7 V to various lower potentials vs. RHE (0V, -0.2V, -0.3V, and -0.4V respectively) (b , e) Correlated *in situ* stress (c, f) first derivative of stress versus potential (a, b, and c) Ar saturated solution (d, e, and f) CO_2 saturated solution.

DISCUSSION:

- Electrochemical analysis shows the changes in surface reactivity toward HER and CO_2 reduction as the surface composition and structure is altered.
  - Under the Ar saturated environment, the stress remains relatively flat, while the CO_2 saturated solution develops a slope as potentials reach more negative values.
- Results from electrochemical surface stress measurements show stress evolutions which correspond to the observed surface reactivity.
  - Ar saturated solution experiences results consistent with previous studies.[6]
- These studies will provide insight into activity and selectivity descriptors for hydrogen production and CO_2 reduction reactions in aqueous media.

FUTURE WORK:

- Baseline experiments for Platinum under the same conditions as Au.
- Electrochemical analysis of the HER and CO_2 reduction on transition metal surfaces such as Cu.
- CV and stress measurements under different pH solutions.

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