Atomic Layer Deposition for Spatial Control of Redox Reaction Selectivity

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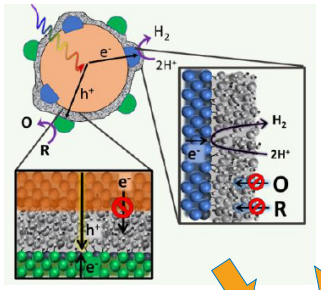
Overview

- Photocatalytic water splitting holds great potential in pursuit of U.S. DOE's Hydrogen Shot to achieve $1/kg by 2031.
- Overall solar-to-hydrogen (STH) efficiency can be increased by enhancing charge separation yields and **redox selectivity**.
- Here, we utilized area selective atomic layer deposition (ALD) for tunable TiO_2 interphase layers that allow selective redox reactions on different areas of a single substrate.

Concept

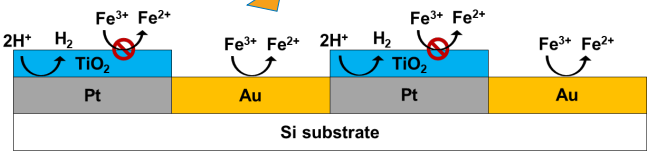


Vision: species selectivities in 3D using multicomponent interfaces

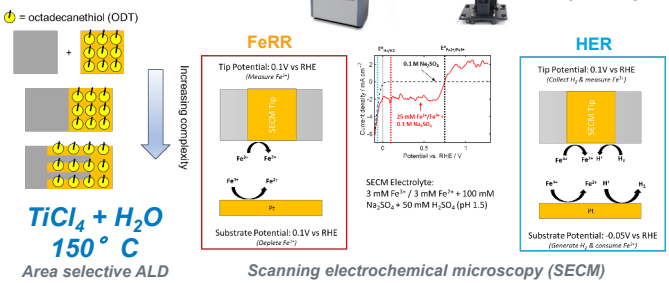
This work: planar analogs to demonstrate ALD and redox selectivity

= Pt

= Au

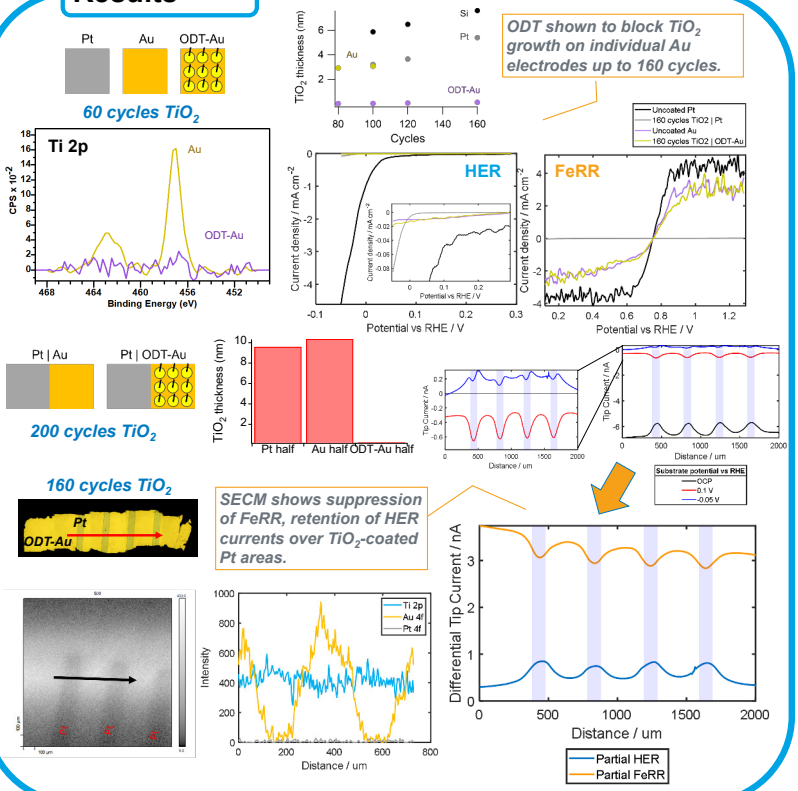


Methods



- Varying substrate aspect ratios, block ALD with **octadecanethiol** (ODT).[1,2]
- ODT removed with post synthesis UV-ozone treatment
- **Scanning electrochemical microscopy** to assess spatial redox selectivity.[3]

Results



Summary and Future work

- ODT self-assembled monolayers can be used to enable area selective ALD growth on varying geometries of Pt-Au electrodes.
- Growth on Pt | ODT-Au electrodes appeared to be selective towards Pt surfaces up to 200 cycles as measured by ellipsometry.
- After ODT removal, **redox selectivity (i.e., HER vs. FeRR current) was demonstrated** on the patterned surfaces.
- Cross-sectional STEM and XPS will be used to further probe the morphology and selectivity of the coatings on substrates with varying aspect ratios.

References

[1] Pasquali M, De Gendt S, Armani S. *Appl Surf Sci* 540 148307 (2021).

[2] Liu, T-L et al. *ACS Appl Mater Interfaces* 12(37) 42226 (2020).

[3] Stinson, WDH et al. *ACS Appl Mater Interfaces* 14(50) 55480 (2022).

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