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Synthesis and Investigation of Tungsten–Copper Oxide Composites for Enhanced Photocatalytic Applications

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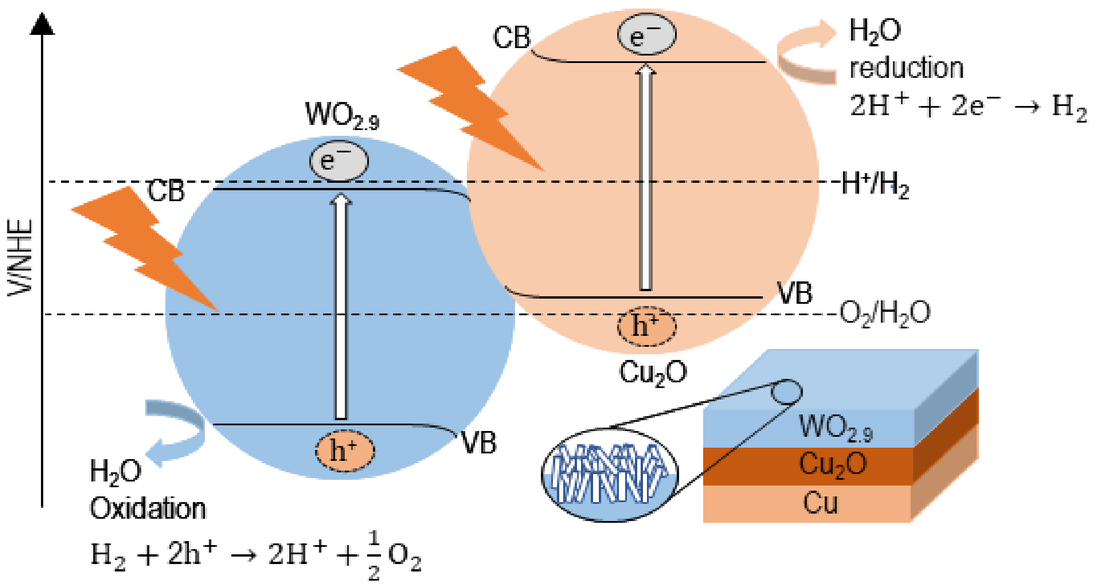
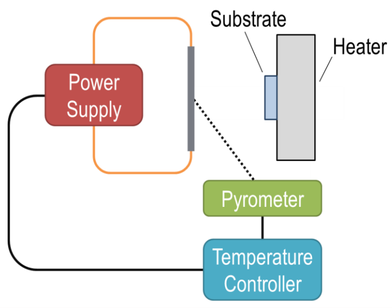
INTRODUCTION & AIM



- Most renewable energy sources have fluctuating power outputs and are commonly difficult to predict.
- Currently, most industrial H_2 production is extracted from fossil fuels.
- Technological innovations like photochemical water splitting offer a green alternative for H_2 production
- Hydrogen can be stored using existing technologies, making it a viable energy carrier..
- Developing visible-light-driven hydrogen production is key to creating efficient, low-cost photocatalysts
- Tungsten oxide is an efficient at oxidizing H_2O, but ineffective at reducing H_2O.
- Copper oxide is an efficient at reducing H_2O, but ineffective at oxidizing H_2O.
- A Z-scheme geometry between $WO_{2.9}$ and Cu_2O will effectively split H_2O.

METHOD

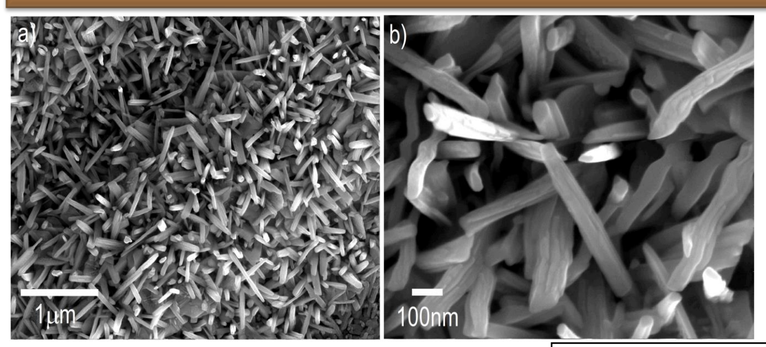
Hot Wire Chemical Vapor Deposition



- Tungsten filaments are heated above the vapor temperature of tungsten oxide.
- $WO_{2.9}$ nanostructures are synthesized on oxidized copper substrates (Cu_2O//Cu).

Growth Conditions	
P_{O_2} (mTorr)	50
$T_{filament}$ (°C)	1200
$T_{substrate}$ (°C)	500
Δt (min)	15

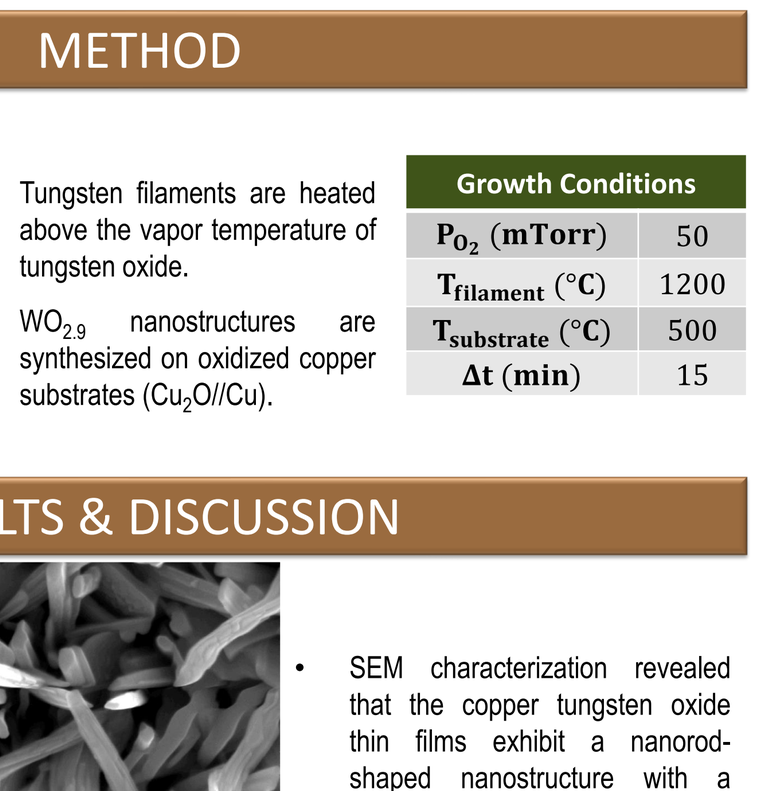
RESULTS & DISCUSSION



- SEM characterization revealed that the copper tungsten oxide thin films exhibit a nanorod-shaped nanostructure with a diameter of ~50 nm

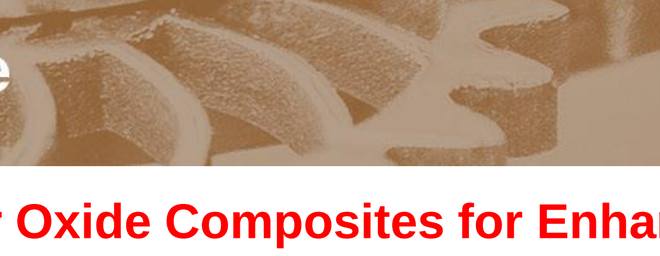
X-ray diffraction

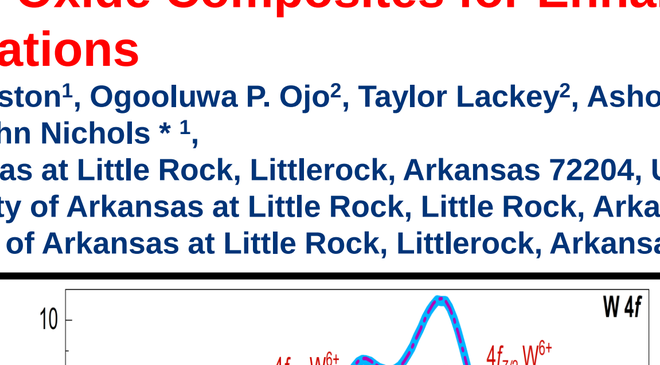
- $WO_{2.9}$ is dominant phase
- $WO_{2.9}$ has preferential growth along *b*-axis
- Cu_2O signal is likely screened by $WO_{2.9}$ nanostructures



Raman

- Sensitive to M-O-M bond stretching and bending
- Features *above* 240 cm^{-1} attributed to $WO_{2.9}$
- Features *below* 240 cm^{-1} attributed to Cu_2O

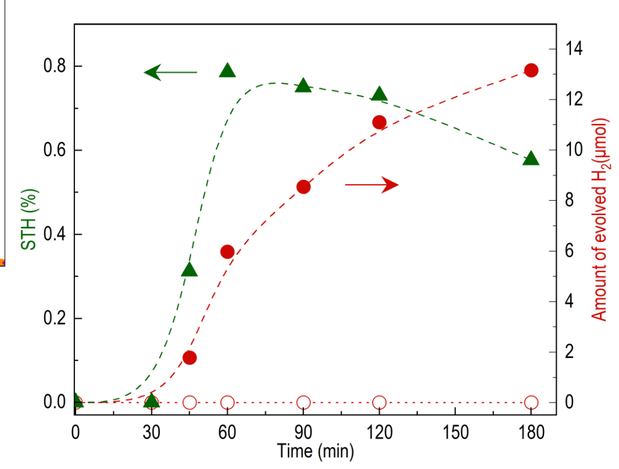




X-ray photoemission spectroscopy

- Presence of multivalent W (W^{5+} and W^{6+})
  - Average oxidation state of $W^{5.8+}$
  - Corresponds to $WO_{2.9}$
- Presence of single valence Cu (Cu^{1+})
  - Corresponds to Cu_2O

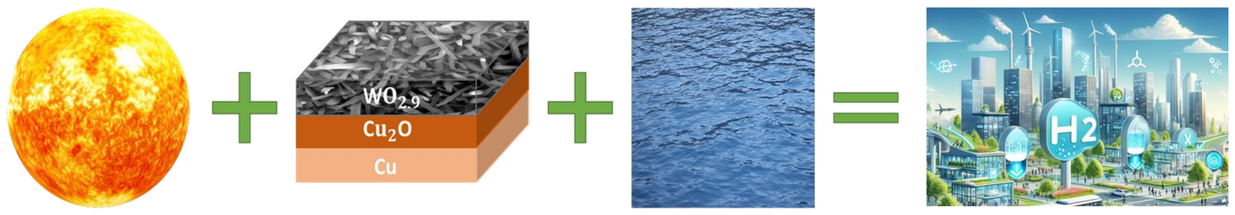
- Under solar illumination, the synthesized samples exhibit substantial enhancement, confirming its effectiveness as a proficient photocatalyst
- During EIS measurements, we observe a twofold reduction in impedance regardless of whether solar light is present



- Indicates presence of H_2 gas after solar illumination
- Maximum STH efficiency ~1%
- Suppression of STH with time due experiment at fixed volume

CONCLUSION/ FUTURE WORK

- We successfully fabricated $WO_{2.9}$ nanostructures on Cu_2O thin films on Cu substrates utilizing the HWCVD technique.
- The samples were photo-catalytically active with an STH efficiency of about 1% without any external bias voltage in water splitting testing in deionized water under illumination of simulated solar light.
- The simple synthesis and alternative material for hydrogen production offer a cost-effective approach, showcasing potential for advanced photocatalysts in next-generation fuel production.



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