TUNGSTEN DISULFIDE as a COUNTER ELECTRODE in DYE-SENSITIZED SOLAR CELLS

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ABSTRACT

- Climate change is a major concern in today's society, research in alternative energy is crucial.
- Solar energy is unarguably the largest source with potential to meet our energy needs.
- The dye-sensitized solar cell (DSSC) is a third generation photovoltaic device that can convert solar energy to electrical energy [1].
- The standard counter electrode material for DSSCs is platinum (Pt) due to high conductivity and catalytic activity. Pt is expensive and a limited resource,
- Tungsten Disulfide (WS_2), a highly lubricous and temperature resistant material, has been explored as a counter electrode material for DSSCs.
- Mechanical and thermal processing techniques were used to attempt to increase its electrical conductivity and catalytic activity.
- A power conversion efficiency of 2.69% was achieved.

BACKGROUND

Environment

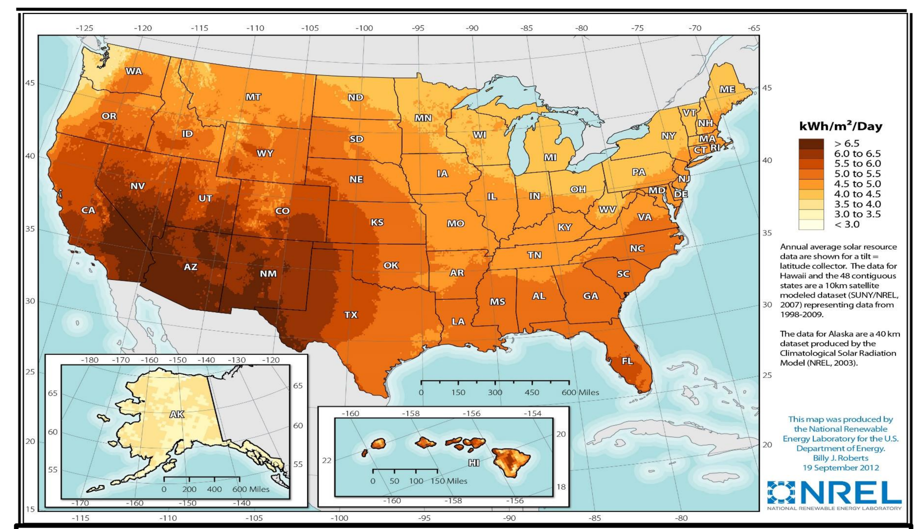

Figure 1. NREL US Photovoltaic Potential Map [2]

Figure 2. NASA Global CO2 Measurement [3]

Dye-Sensitized Solar Cell

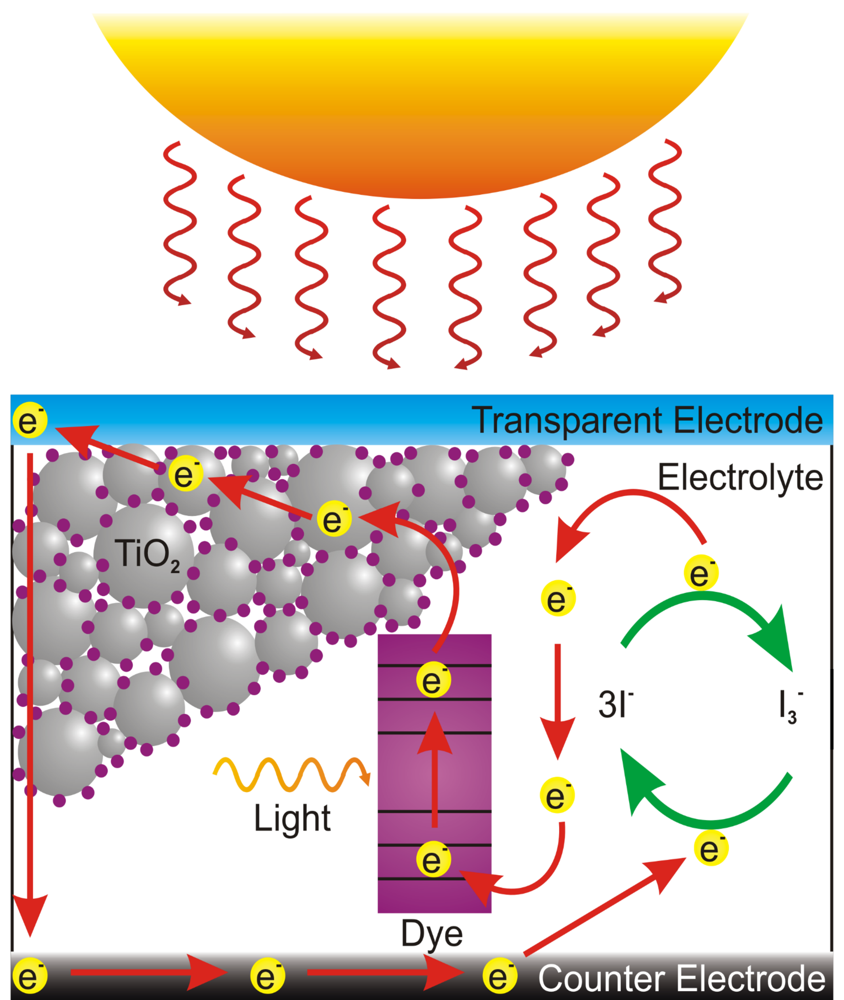

Figure 3. DSSC Diagram [4]

METHODS

Fabrication → **Testing** → **Data Analysis**

Processing Techniques
- Ball Milling
- Heat Treatment

Testing Methods
- Linear Sweep Voltametry (IV)
- Electrochemical Impedance Spectroscopy (EIS)
- Cyclic Voltametry (CV)
- X-Ray Diffraction (XRD)
- Conductivity (Sheet Resistance)

RESULTS

Table 1. Sample Processing Techniques

Sample	Processing Technique
1	-
2	10min Ball Milling
3	1hr Ball Milling
4	2hr Ball Milling
5	10min @ 350˚F
6	1hr @ 350˚F
7	2hr @ 350˚F

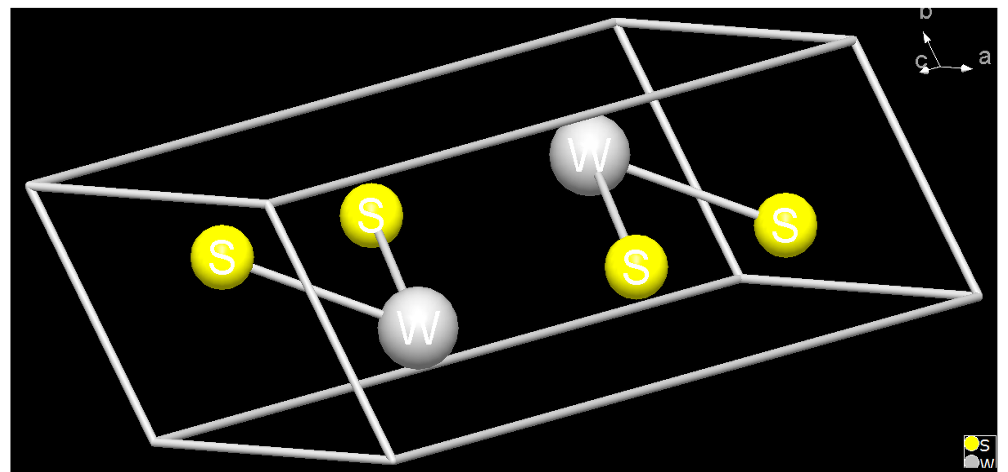

Figure 4. WS2 2H Phase Crystallographic Orientation [5]

Table 2. Sample XRD Data

Sample	Peak Intensity (cps)	Particle Size (nm)
1	3158.33	64.2692206
2	1783.33	51.08916547
3	620	23.69615916
4	473.33	13.89036002

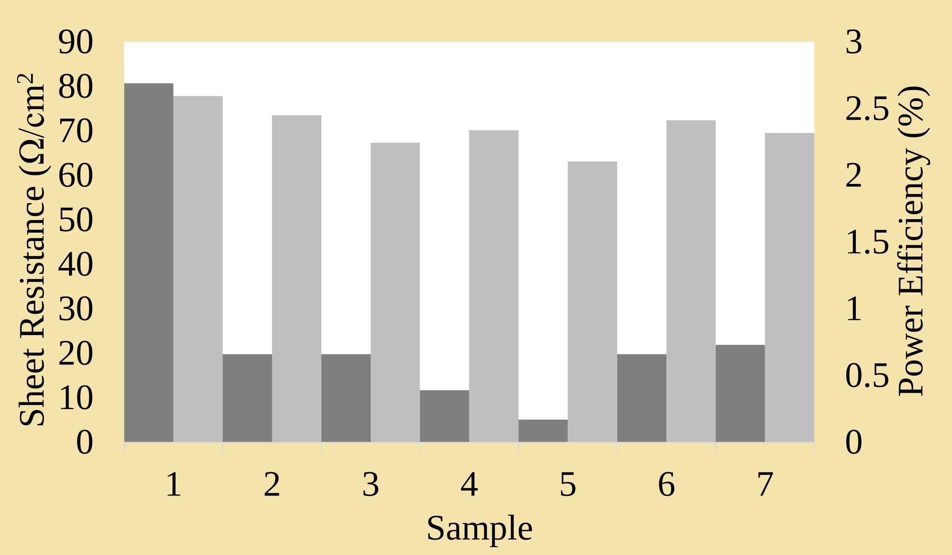

Figure 5. Sheet Resistance & Efficiency

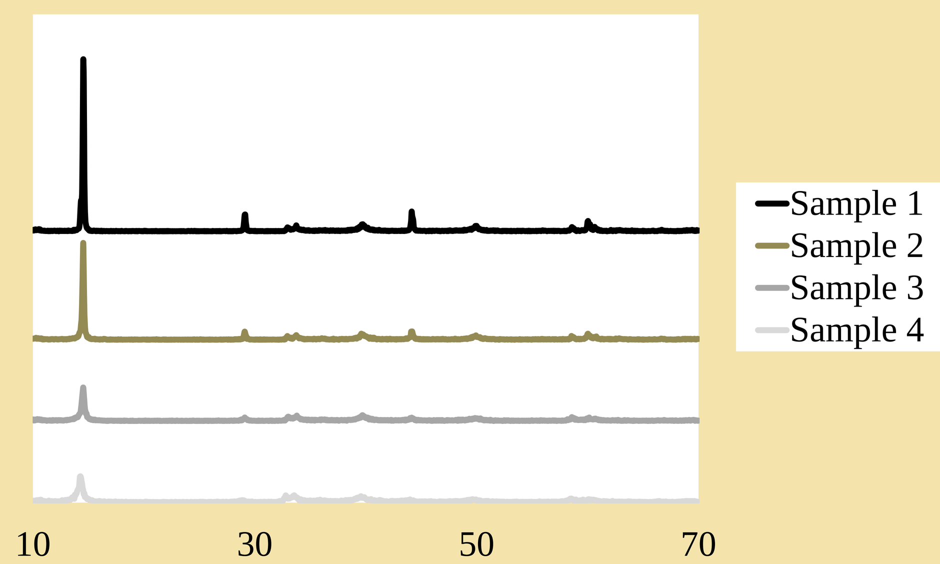

Figure 6. XRD Patterns for Ball Milled Samples

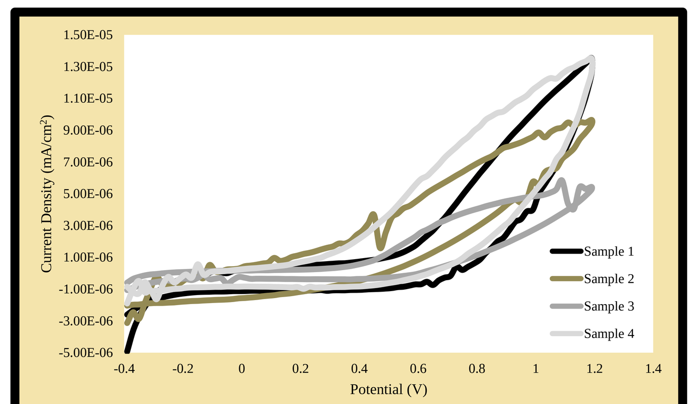

Figure 7. CV Curve for Ball Milled Samples

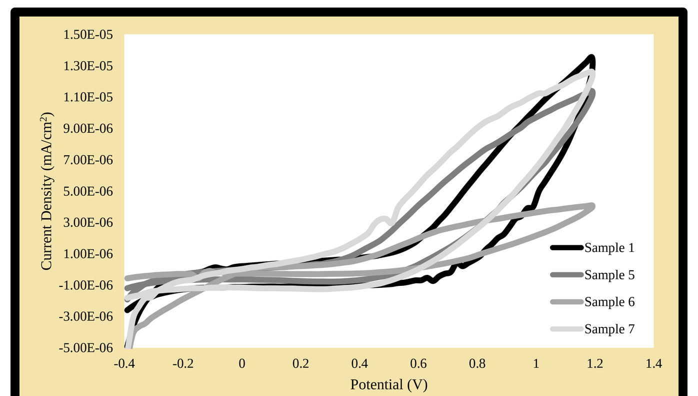

Figure 8. CV Curve for Heat Treat Samples

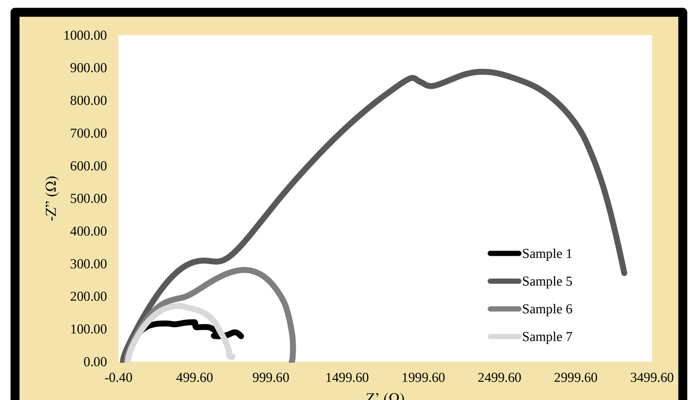

Figure 9. EIS Analysis for Heat Treat Samples

CONCLUSION

- WS2 showed excellent performance as counter electrode materials in dye-sensitized solar cells, leading to a power conversion efficiency of 2.69%.
- Crystal particle sizes were determined by XRD measurement.
- Smaller crystal particle size resulted in lower power conversion efficiency.
- CV and EIS were also employed to evaluate the electrochemical performance.
- This work demonstrated the feasibility to develop low-cost, high efficient and abundant metal dichalcogenide electrocatalysts (WS2) to replace Pt for photovoltaic applications.

REFERENCES

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ACKNOWLEDGEMENT

Thanks to the Charles and Carroll McArthur Internship Program for support, Dr. Yun Hang Hu, PhD Candidate Wei Wei, and Future for guidance.