Creating More Efficient Solar Cells Using Mott Insulators V_2O_3 and $LaVO_3$

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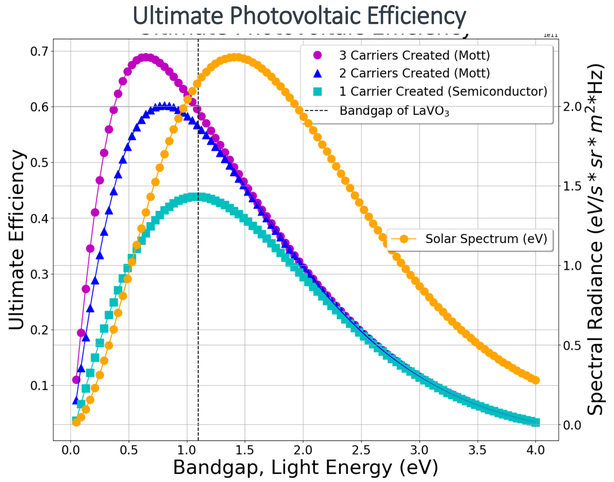
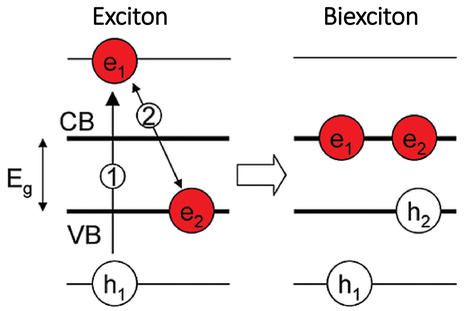
Background



- Ordinary semiconductors do not efficiently harvest the short wavelengths in the solar spectrum
- In a Mott (strongly correlated) insulator, multiple electrons can be excited by a short wavelength photon
- Vanadium oxides are good Mott insulators



(*J. Phys. Chem. C* 2010, 114, 9, 3743−3747)

Objectives

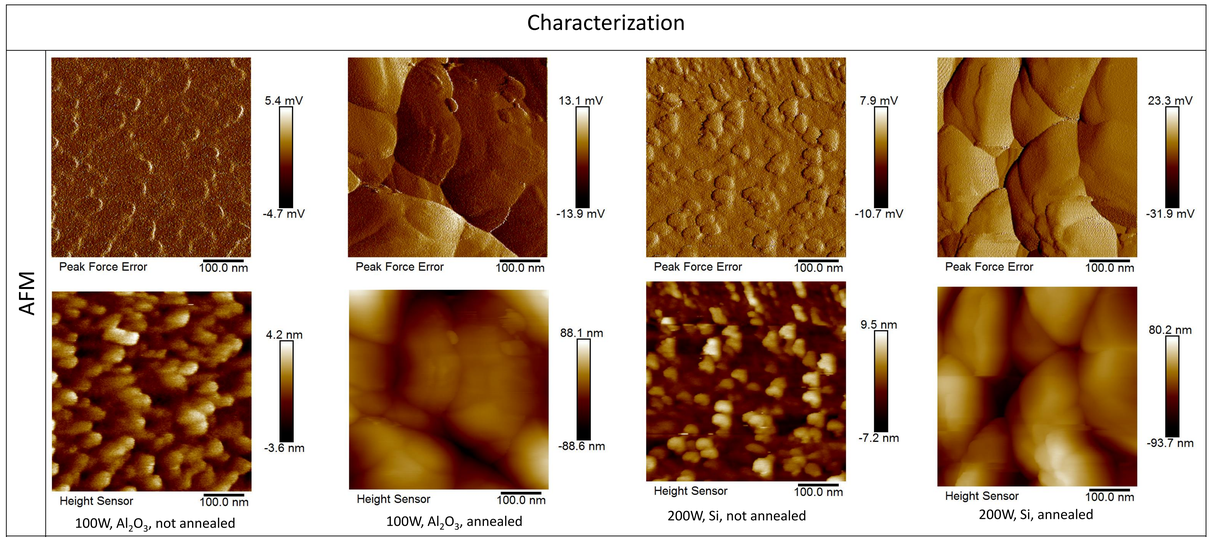
I. Create recipe for V_2O_3 and $LaVO_3$ (LVO) films

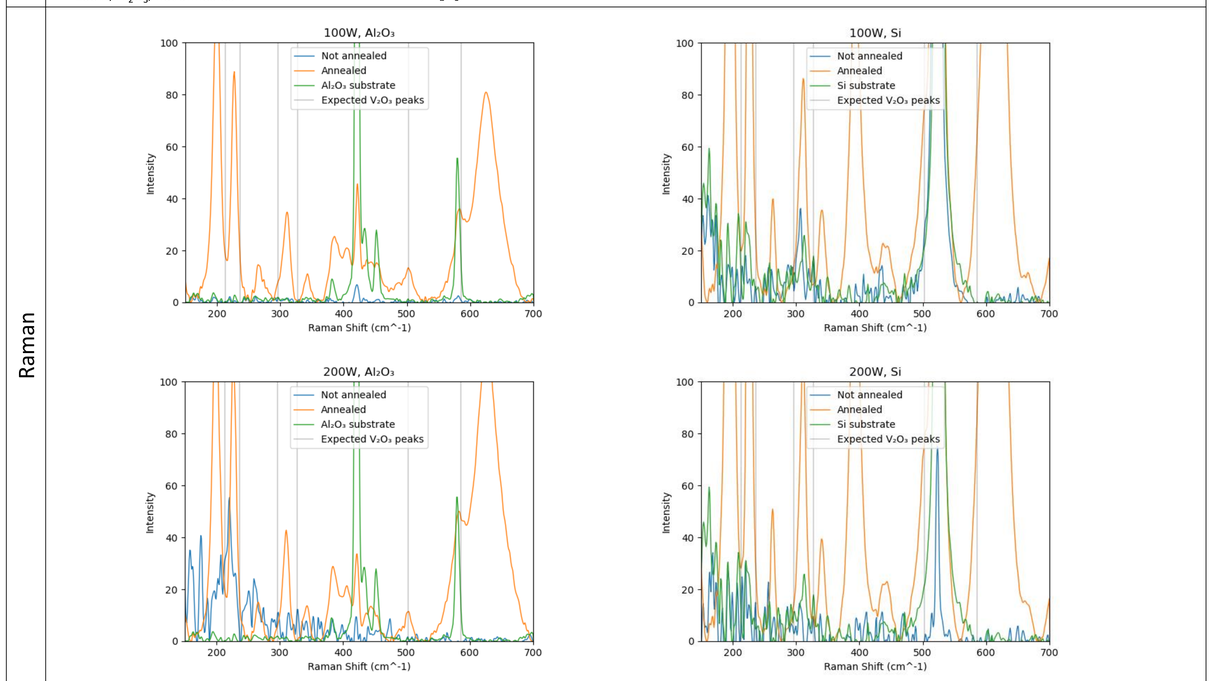
II. Synthesize V_2O_3 samples with varying:
- Substrate
- Annealing conditions
- Deposition wattage

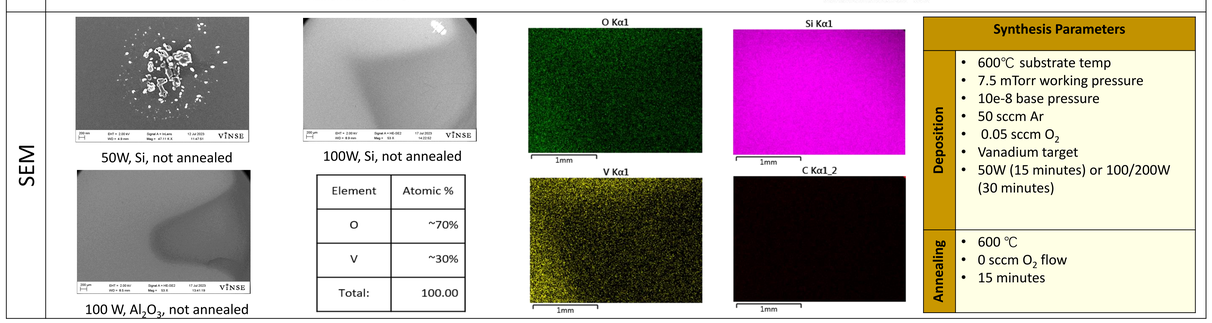
III. Characterize V_2O_3 samples using:
- Atomic Force Microscopy: topography
- Raman Spectroscopy: composition
- Scanning Electron Microscopy: morphology

Can Mott insulators create more efficient solar cells due to multiple exciton generation?

Results







Element	Atomic %
O	~70%
V	~30%
Total:	100.00

	Synthesis Parameters
Deposition	• 600℃ substrate temp • 7.5 mTorr working pressure • 10e-8 base pressure • 50 sccm Ar • 0.05 sccm O_2 • Vanadium target • 50W (15 minutes) or 100/200W (30 minutes)
Annealing	• 600 ℃ • 0 sccm O_2 flow • 15 minutes

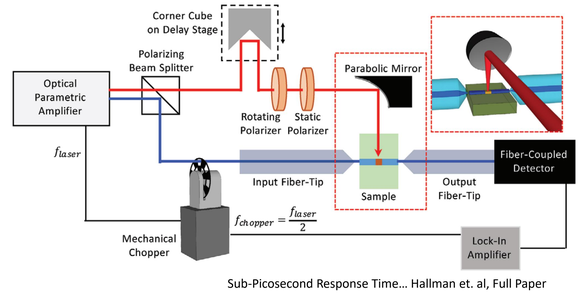
Observations

Synthesis and characterization of sputtered vanadium metal target in low pressure oxygen followed by occasional annealing found:

- 50W power to the vanadium target during sputtering deposition is not enough to form a quasi-continuous thin film
- Annealing improves Raman shift, makes crystalline domains larger, and increases the roughness
- Film can grow on both Al_2O_3 and Si substrates
- V_2O_3 stoichiometry has not yet been achieved

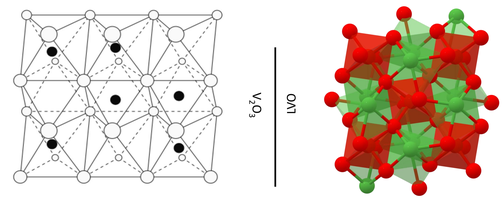
Future Work

- XRD and EDS for quality V_2O_3 films
- Synthesize and characterize $LaVO_2$ films



Sub-Picosecond Response Time... Hallman et. al, Full Paper

- Measure change in conductivity as a function of laser energy with ultrafast experiments and V2O3 films



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Data retrieved from the Materials Project for LaVO3 (mp-19350) from database version v2022.10.28.

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