Creating More Efficient Solar Cells with Vanadium Oxide Thin Films

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Abstract

Conventional solar panels currently operate at a low efficiency of approximately 25%. However, Mott insulators present a promising avenue for enhancing solar energy conversion as they have shown a theoretical potential to achieve over 65% efficiency. Impaction ionization occurs in a semiconductor if the kinetic energy of the charge carrier is greater than twice the bandgap, which may then excite an additional electron-hole pair. In Mott insulators, this process occurs over one hundred times faster than a typical semiconductor (i.e. silicon), which contributes to almost doubled efficiency, and the possibility of creating multiple charge carriers per photon absorption. The Mott insulator proposed to be used in solar energy is LVO (lanthanum vanadium oxide). However, this research focuses on V2O3 because it is a strongly correlated material that is easier to work with in the preliminary investigation of the multiexciton generation process. The films were synthesized using sputtering and annealing techniques, and characterized with x-ray diffraction, Raman spectroscopy, scanning electron microscopy, and atomic force microscopy. Using this model Mott insulator thin film, we successfully established a reliable recipe detailing the sputtering and annealing procedures for producing quality thin V2O3 films. This investigation contributes to the advancement of solar panel technology by providing a better understanding of Mott insulator synthesis and offering a potential avenue for improving solar energy conversion efficiency by studying impact ionization in a model Mott insulator system.

Biography of Presenter

Erin Burgard is an honors undergraduate senior at Arizona State University, where she majors in Environmental Engineering and minors in Spanish and Environmental Humanities. This summer, she is researching at Vanderbilt University, where she is synthesizing and characterizing Mott insulators for solar cell applications. At ASU, she researches the stress response of perovskite thin films for use in solar cells. This work was supported by her honors thesis which was defended in May 2023 and awarded the Bidstrup fellowship, Mensch prize, Jaap Sustainability scholarship, and Fulton Undergraduate Research Initiative. Erin also works with the international water treatment non-profit 33 Buckets and spent two months in the rural communities in the outskirts of Cusco, Peru conducting research surveys and assessments. Within ASU, Erin worked as a first-generation engineering student mentor for the Fulton Engineering School with the objective to increase the retention of first-generation students in engineering. She also started a small business selling handpainted cards. She will graduate in May of 2024.