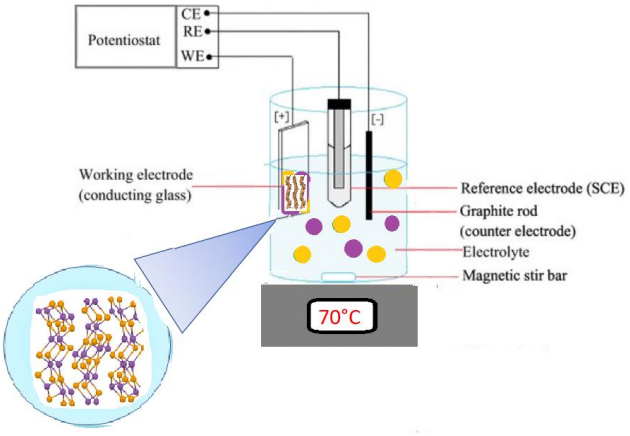
How Thermal and Chemical Treatments Affect the Electrochemical Deposition of Sb_2Se_3 for Use in Photovoltaics

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Abstract

For the improvement of energy harvesting techniques, recent studies explore a variety of materials and deposition methods to grow/synthesize a variety of solar cell layers such as the window layer, back mirror layer, back surface field layer, and perhaps the most important and functional layer, the absorber layer. Sb_2Se_3 has been proposed as a promising option as the absorber layer used in photovoltaic devices. While these thin films have been produced in several ways including reactive pulse laser deposition, spin-coating, spray pyrolysis, close space sublimation (CSS), thermal evaporation, and physical and chemical vapor deposition, many of these are considered non-uniform and/or expensive and very little work has been done on Sb_2Se_3 electrochemical deposition techniques nor the effect of pre- and post-deposition chemical substrate, annealing, and seeding treatments. Electrochemical deposition has minimal waste generation, easy initial set up, low cost, and with the one reusable chemical bath, repeatability. Many characterization techniques were performed including optimal microscopy, scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD), grazing Incidence X-ray Diffraction (GIXRD), surface photovoltage (SPV) measurements, ultraviolet–visible (UV-Vis) spectroscopy, photoelectrochemical (PEC) measurements, and atomic force microscopy (AFM) for thorough surface characterization. These results show that not only was the target film composition, Sb_2Se_3, achieved via electrochemical bath deposition alone, but also it can be improved by a variety of a pre and post-deposition annealing treatments during which the deposited films are annealed in an argon atmosphere in the presence of pristine selenium powder, antimony powder or both. This pre-deposition anneal effectively deposits seeds which can then grow when in the presence of precursors in the electrochemical bath. This work explores a variety of parameters which can be tuned to affect the film's morphology, composition, bandgap, and performance.

Image



Recent Publications

1. Cassondra M. Brayfield, "Toward a green community: Tuning electrochemical parameters to improve morphology of Sb_2Se_3 solar absorber Layers" American Ceramic Society Bulletin, Vol. 102, No. 5
2. Cassondra M. Brayfield, Subhash Risbud et al "Electrochemical Deposition of Sb_2Se_3 for Use in Photovoltaics" Submitted to Resolution and Discovery.
3. Cassondra M. Brayfield, Cody R. Carr, Louise A. Berben et al "Secondary Coordination Sphere Cations Break Scaling Relationships for Hydrogen Evolution Rate" -Not yet submitted for publication.
4. Kentaro Yumigeta, Cassondra Brayfield, Sefaattin Tongay et al,. "The Synthesis of Competing Phase GeSe and $GeSe_2$ Ultrathin Materials" RSC Advances, published by the Royal Society of Chemistry
5. Kedi Wu, Bin Chen, Mark Blei, Lei Liu, Hui Cai, Cassondra Brayfield, David Wright et al. "Phase trans ition across anisotropic superconducting NbS3 and direct gap semiconductor TiS3 at nominal titanium alloying limit." Advanced Materials

Biography



Cassondra is a PhD candidate of Material Science and Engineering at the University of California, Davis. Her career includes a bachelors from Rensselaer Polytechnic Institute, Master's work at Arizona State University, and industry roles in startups like smart lighting and BESS Tech (Battery Energy Storage Systems Technology), but also roles in large corporations like fractographer at Corning Inc. and Yield Engineer at Intel. She is currently working on a variety of energy harvesting and storage projects including synthesizing iron-based catalysts for the production of alternative fuels and depositing and tuning the absorber layer for photovoltaics/solar cells. When not researching or teaching, she is also interested in ballet, wine tasting, swimming, reading, throwing parties, travel, and all things outdoors. After graduating with her PhD, she hopes to rejoin industry as a research and development scientist at a battery company to make greener and/or lithium-free batteries.

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