Solution-Processed Thin Film Semiconductors for Photovoltaic and Photoelectrochemical Applications

Abstract

Renewable energy technologies, such as photovoltaics (PV), have been identified by the Intergovernmental Panel on Climate Change (IPCC) to play a leading role in the necessary transition away from fossil-combustion-based energy sources. However, hurdles for widespread implementation such as cost competitiveness and the inherent energy intermittency of solar energy must be overcome. Ink-based deposition techniques have the potential to advance renewable energy technologies due to their low capital expenditure, high material utilization, and high throughput, if high device efficiencies and benign reaction mechanisms can be obtained. Thin film solar cells based on chalcogenide and perovskite absorbers are particularly promising as they have achieved efficiencies over 23% and can be fabricated by liquid deposition methods and on rigid or flexible substrates. They also allow for their integration in solution-processed tandem solar cells to further boost device efficiencies by over 40%. The high voltages from tandem devices facilitate their use in catalysis reactions for solar fuels. The photoelectrochemical (PEC) reduction of CO_2 has received growing attention as a potential solution to the intermittency of PV while reducing the amount of excess CO_2 in the atmosphere. Similar to PV, low-cost deposition methods and materials for catalysts and PEC devices are needed to support the growth of cost-competitive solar fuels.

Biography

Dr. Alexander R. Uhl is an Assistant Professor at the School of Engineering (Mechanical, Electrical) at UBC Okanagan and Principal Investigator of the Laboratory of Solar Energy and Fuels (LSEF). He received his PhD in Materials Science and Engineering from the Swiss Federal Institute of Technology in Zurich (ETH), Switzerland and Diploma in Nanoscale Engineering from the University of Würzburg, Germany after graduate stays at the University of British Columbia, Canada and Uppsala University, Sweden. As a three-time fellow of the Swiss National Science Foundation (SNSF) he conducted postdoctoral research at the University of Washington, USA with Prof. Hugh Hillhouse and at the Swiss Federal Institute of Technology in Lausanne (EPFL), Switzerland with Prof. Michael Graetzel and Prof. Anders Hagfeldt.

With over a decade experience in materials and technologies for solar energy conversion, Dr. Uhl develops printed solar cells, tandem devices, and photoelectrochemical devices for clean and renewable electricity and storable fuels. His devices currently hold the world record for the highest certified power conversion efficiency for $CuIn(S,Se)_2$ solar cells from any non-vacuum process. Dr. Uhl has filed two patents on solution-processed chalcogenide solar cells, is the author of an invited book chapter on perovskite solar cells, Guest Editor for the scientific journal Thin Solid Films, and Associate Editor for Frontiers in Energy Research.