



Controlling morphology and self-assembly in solution-processed semiconductor devices

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The development of semiconducting materials that can be solution-processed into functional thin-films at low temperature, while simultaneously providing excellent device characteristics, represents a significant challenge for materials chemists and engineers. Attaining this goal will provide access to low-cost, large area and flexible displays, sensors and solar cells. In this presentation I will present the challenges to enable high performance in solution-processed semiconductors and highlight our group's approach to control morphology, self-assembly, and interfaces of different classes of solution-processable semiconductors based on their dimensionality: from 0-D oxide and sulfide nanoparticles to 1-D conjugated polymers and 2-D transition metal dicalcogenide nanosheets.

Further, I will show how our approaches allow for insight into the nature of the semiconductor band gap, light absorption, charge transfer, and carrier transport in functional thin films, and indicate routes for improvement. In addition, the application of our material systems in functional devices especially for solar energy conversion will be emphasized.

Recent Publications:

- (1) Gasperini, A.; Sivula, K. Effects of Molecular Weight on Microstructure and Carrier Transport in a Semicrystalline Poly(thieno)thiophene. *Macromolecules* **2013**, *46*, 9349-9358.
- (2) Sivula, K. Metal Oxide Photoelectrodes for Solar Fuel Production, Surface Traps, and Catalysis. *J. Phys. Chem. Lett.* **2013**, *4*, 1624-1633.
- (3) Gasperini, A.; Bivaud, S.; Sivula, K. Controlling conjugated polymer morphology and charge carrier transport with a flexible-linker approach. *Chem. Sci.* **2014**, *5*, 4922-4927.
- (4) Guijarro, N.; Prévot, M. S.; Sivula, K. Enhancing the Charge Separation in Nanocrystalline Cu₂ZnSnS₄ Photocathodes for Photoelectrochemical Application: The Role of Surface Modifications. *J. Phys. Chem. Lett.* **2014**, 3902-3908.
- (5) Yu, X.; Prévot, M. S.; Sivula, K. Multiflake Thin Film Electronic Devices of Solution Processed 2D MoS₂ Enabled by Sonopolymer Assisted Exfoliation and Surface Modification. *Chem. Mater.* **2014**, *26*, 5892-5899.