Photoelectrochemical Properties of 2-D Transition Metal Dichalcogenides(TMDCs) Functionalized with Porphyrins

Ramani, Arjun

Recently, cutting edge 2-D materials have emerged in the field of photovoltaics for light energy conversion. Graphene, the 2-D version of graphite, has a high carrier mobility, transparency, and mechanical strength making it well suited for electronic applications. Still, the issue with graphene is its 0-bandgap allowing electrons to jump bands too easily for applications. TMDCs(Transition Metal Dichalcogenides) are semiconductors that have a sizeable band gap at the single-layer (1.9 eV). They possess the unique ability to change from indirect to direct bandgap as the number of layers decreases. This project confirms the differences in optical properties between thin and bulk layer TMDCs (MoS2). In addition, the project develops Improved methods for synthesizing large area uniformly distributed thin layer TMDC. Secondly, the light harvesting capabilities of thin layer TMDCs bound to porphyrins are explored. Porphyrins are chromophore molecules similar to chlorophyll with high intensity absorption bands. To this point, the capabilities of TMDCs bound to porphyrins for light energy conversion to current through electron transfer are not well known. This project shows an increase in photocurrent generation TMDCs when bound to porphyrin-like materials. This is the first proof-of-concept demonstration for porphyrins acting as electron donors for energy conversion with TMDCs, opening the door for much further research in the field of 2-D semiconductors for light energy conversion. As renewable energy becomes more important, this area of light energy conversion has seen skyrocketing interest.

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