
Two-dimensional materials, particularly graphene and monolayer transition metal dichalcogenides (TMDCs), have gained attention in the scientific community due to their impressive optoelectronic properties, particularly extraordinarily high optical absorption per monolayer. Within this class, several monolayer TMDCs are uniquely well-suited to making ultrathin, low cost solar cells, with bandgaps between 1.4-1.8eV, and 5-10% optical absorption per atomic layer across the solar spectrum. Despite these superior qualities, for TMDCs to succeed as solar cells it is necessary to build devices that can absorb 100% of incident light. And so, this project has focused on using light-trapping techniques uniquely possible in 2D materials in order to significantly enhance the absorption into our active monolayer material. Up to 24.5% absorption has been demonstrated experimentally in graphene, and a theoretical enhancement up to 40% has been shown in monolayer MoS2.

Catalysis without Precious Metals: Lessons from Nature in Sustainable Chemistry

Catalysts based on precious metals such as palladium and rhodium are used in the production of medicines, crop protection agents, cosmetics, and plastics. Unfortunately, the continued use of these metals is unsustainable due to rapidly depleting reserves, high cost, and toxicity issues.

In stark contrast, Nature has evolved to use abundant, non-toxic metals such as iron and potassium to enable its sustainable biological processes.

Inspired by Nature’s chemistry, we sought to develop an Earth-abundant metal catalyst that could supplant precious metals in both laboratory- and industrial-scale chemical synthesis. Details of a recent discovery will be presented.