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Semiconductor nanostructures for artificial photosynthesis

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Nanowires, with their unique capability to bridge the nanoscopic and macroscopic worlds, have already been demonstrated as important materials for different energy conversion. One emerging and exciting direction is their application for solar to fuel conversion. The generation of fuels by the direct conversion of solar energy in a fully integrated system is an attractive goal, but no such system has been demonstrated that shows the required efficiency, is sufficiently durable, or can be manufactured at reasonable cost. One of the most critical issues in solar water splitting is the development of a suitable photoanode with high efficiency and long-term durability in an aqueous environment. Semiconductor nanowires represent an important class of nanostructure building block for direct solar-to-fuel application because of their high surface area, tunable bandgap and efficient charge transport and collection. Nanowires can be readily designed and synthesized to deterministically incorporate heterojunctions with improved light absorption, charge separation and vectorial transport. Meanwhile, it is also possible to selectively decorate different oxidation or reduction catalysts onto specific segments of the nanowires to mimic the compartmentalized reactions in natural photosynthesis. In this talk, I will highlight several recent examples in this lab using semiconductor nanowires and their heterostructures for the purpose of direct solar water splitting.