Artificial photosynthesis enabled by nature's blueprints and building blocks

Elena A Rozhkova
Argonne National Laboratory, USA

The biological use of the solar energy for syntheses of fuels from water and carbon dioxide has been inspiring researchers and engineers in their efforts to replace current exhaustible energy sources to renewable energy technologies. Environmentally friendly schemes of photocatalytic visible-light hydrogen production known as artificial photosynthesis along with inorganic semiconductor material also utilize biological structures, such as enzymes, machineries of whole microorganism, capable of light-harvesting, water splitting, carbon dioxide and proton reduction. We have been developing visible-light-driven nano-bio photocatalysts for hydrogen production based on non-covalent assemblies of the natural and synthetic membrane proton pump and TiO2 semiconductor nanoparticles. A natural membrane complex of retinal-containing proton pump bacteriorhodopsin (also known as purple membranes, PM) from the extremophile microorganism Halobacterium salinarum has been attracting an attention of researchers owing to its exceptional robustness, excellent photophysical properties, and structure−functional elegance. We demonstrated applicability of PMs in sunlight transformation systems constructed from TiO2, boosted with introduction of reduced graphene oxide rGO, or more recently, constructed as entirely synthetic PM – semiconductor architecture using cell-free synthetic biology approach. Merging nanotechnology and synthetic biology approaches allows for systemic manipulation at the nanoparticle−bio interface toward directed evolution of energy materials, novel catalytic systems and artificial life structures.

e: rozhkova@anl.gov