Clean Hydrogen Production From Photocatalytic Degradation of Plastic Wastes

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Hydrogen (H2) is identified as a clean energy source and can be produced from fossil fuels and biomass gasification, and water splitting using electrolysis. However, the current H2 production processes are expensive and intensive. Photo-reforming is an attractive H2 production technology that can use solar energy and plastic wastes as feedstock. Globally, it is estimated 448 million metric tons of plastics are generated annually and 60% become environmental pollutants. The accumulation of recalcitrant plastics has caused significant concerns about their health risks and ecological impacts. Conversion of high-volume plastic wastes to H2 is critical to protect public health and ecological systems while generating a clean energy source for a net-zero-carbon economy. This project developed an innovative technology by converting abundant plastic wastes to H2 using a low-cost, solar photo-reforming process. High-performance photocatalysts were synthesized by doping Au nanoparticles onto TiO2 to improve light utilization and catalytic activity by reducing the energy bandgap and recombination rate of generated radicals. Laboratory experiments demonstrated photo-reforming was effective for H2 production by degrading a variety of common plastics, such as polyethylene (PE), high- and low-density polyethylene (HDPE and LDPE), polyethylene terephthalate (PET), and polystyrene (PS). The low- and medium-grade plastics (LDPE, PE, and PS) produced the highest amount of H2. The recyclable high-grade plastics (PET and HDPE) generated a lower amount of H2 due to their stronger chemical bonds and low H ratio. This project provides a low-cost clean H2 production technology while improving environmental sustainability by reducing greenhouse gas emissions and remediating plastic contamination.

Awards Won:
Third Award of $1,000