Photo-reforming of waste plastics under UV and visible light for H_2 production using nanocomposite photocatalysts

Method of Hydrogen Manufacturing using Waste Plastics

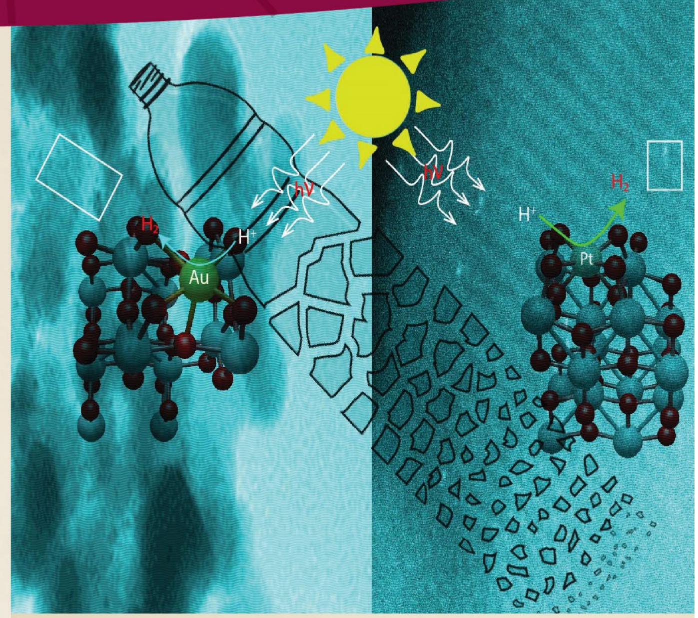
Innovation & Solution

The innovation involves a photocatalysts slurry system devised to produce Hydrogen gas from pre-treated plastic particles in an alkaline solution under light irradiation. It employs advanced nanocomposite photocatalysts, such as Gold-modified Titanium Dioxide (Au/TiO_2) that expands light utilization from UltraViolet (UV) to the visible light spectrum. This approach is significantly energy-efficient and financially viable for producing Hydrogen under both UV and visible light.

Distinctively, the technology is not only affordable and easy to operate but also ecologically sustainable. It transforms large volumes of waste plastics into valuable substances and Hydrogen gas, demonstrating a comprehensive waste and energy management. Moreover, the technology operates under ambient temperature and pressure, negating the need for high-temperature conditions seen in conventional methods such as steam-methane reforming.

Benefits

- Cost-effective and energy-efficient Hydrogen production
- Environmentally sustainable solution for waste plastic management
- Utilization of both UV and visible light spectrum for operation
- Conversion of waste plastics into valuable substances.
- Works under ambient temperature and pressure, alleviating high resource consumption



Background & Problem

Achieving affordable, green sources of energy is pivotal to a sustainable future. Hydrogen is identified as an ideal renewable energy candidate, but its production is costly and requires high-energy inputs. Existing processes, like steam-methane reforming, need high-temperature steam and pressure. Meanwhile, large volumes of plastic waste (globally, 275 million metric tons per year) pollute the environment and cause risks to public health. Hence, a green, cost-effective method to produce hydrogen while simultaneously addressing the global plastic waste problem is urgently needed to achieve environmental sustainability and carbon neutrality.

Inventor and NMSU Department
Huiyao Wang
Pei Xu
Thiloka Edirisooriya
Civil Engineering | NMSU

Arrowhead Center, NMSU
Office of IP and Tech Transfer
575.646.6120 or ip@nmsu.edu
arrowheadcenter.nmsu.edu

ARROWHEAD CENTER®

Photo-reforming of waste plastics under UV and visible light for H_2 production using nanocomposite photocatalysts

Method of Hydrogen Manufacturing using Waste Plastics

Commercial Applications

- Produced H_2 can be directly used as an energy source or for other industry and chemical uses
- Non-recyclable polymer waste management-separate and use different types of plastics for hydrogen production
- Chemical extraction by converting plastics to monomers (such as terephthalic acid (TPA) and to ethylene glycol (EG))
- Recycling the polymer from extracted monomers
- The system can be used for splitting water to H_2 and O_2

Novel Features

- Developed a photocatalysts slurry system with pre-treated plastic particles in an alkaline solution to generate H_2 under light irradiation
- Developed high-performance, innovative nanocomposite photocatalysts (such as Au modifiedTiO_2 and other nanocomposites) that expanded light utilization from UV to the visible light spectrum
- Demonstrated the energy efficiency and cost-effectiveness of producing H_2 under both UV and visible light
- Degraded and converted large volumes of waste plastics to valuable substances during the process while producing H_2. This process can be further developed into valuable chemical extraction from plastics and splitting water to H_2 and O_2.

Advantages of Producing Hydrogen through Photo-Reforming of Plastic

- Operation under ambient conditions using solar energy
- Photocatalysts can be recycled, regenerated, and reused
- Remediation of abundant plastic waste by converting these environmental contaminants into clean H_2 through a combination of pre-treatment, hydrolysis and photo-oxidizing.
- Extract valuable byproducts to manufacture plastics and split water into hydrogen and oxygen.

Cost Analysis

- The cost of managing plastic waste is more than $32 billion annually
- In 2019, the US spent approximately $2.3 billion on plastic disposal
- The market value of landfilled plastic ranges from $4.5 - $9.9 billion

Catalyst	Cost per Gram	Gross Rev per KG / day
5% (w/w) Au/TiO_2	$0.095	$40.50 per KG of PET
0.7% (w/w) Pt/TiO_2	$0.080	$85.00 per KG of PET
0.04% (w/w) Pt/TiO_2	$0.013	$76.00 per KG of PET

Inventor and NMSU Department
Huiyao Wang
Pei Xu
Thiloka Edirisooriya
Civil Engineering | NMSU

Arrowhead Center, NMSU
Office of IP and Tech Transfer
575.646.6120 or ip@nmsu.edu
arrowheadcenter.nmsu.edu

ARROWHEAD CENTER® NM STATE