Upcycling waste plastics with sunlight

BACKGROUND

Traditionally, the term “photoreforming” refers to the use of light energy to drive the conversion of waste feedstocks into sustainable fuels and / or chemicals, such as the production of hydrogen from biomass using sunlight. In recent years this approach has been applied towards a different feedstock: waste plastics, a response to the growing environmental concerns posed by such materials.

In this invention, photoreforming is combined with a enzymatic pretreatment step which allows unsorted waste plastics to be converted into a variety of breakdown products, typically oxidisable monomers and oligomers. For example, PET (or polyethylene terephthalate) can be enzymatically converted into ethylene glycol and terephthalic acid. When subsequently irradiated in the presence of a photocatalyst, the breakdown mixture generates hydrogen and value-added liquid products (e.g., formic acid).

The innovative integration of the mild aqueous enzymatic pretreatment step (at near neutral pH and moderate temperatures) with photoreforming allows the circumvention of harsh alkaline pretreatment approaches (pH > 14 and elevated temperatures) used conventionally, with enhanced green hydrogen evolution activity (> 500 µmol per gram of catalyst per hour), thereby making the process economically and sustainably viable, and a step closer to commercial adoption.

Watch video: Plastic: the new fantastic?

TECHNOLOGY OVERVIEW

- The technology can be used to convert waste plastics into high purity green

hydrogen

- The yield of hydrogen production is improved by first the plastic(s) with a cheap, recyclable catalysts
- Costs of hydrogen production are estimated to be lower than for conventional alkaline pretreatment approaches

BENEFITS

- Utilises waste plastics in a low energy process
- Removes the need for costly and hazardous alkaline pre-treatment processes
- Produces large quantities of high purity green hydrogen
- Additional revenues may be recouped either from recovering high value monomers or other chemicals

APPLICATIONS

The technology could be of interest to:

- Plastic recyclers
- Manufacturers and downstream convertors of plastics
- Members of the green hydrogen supply chain

OPPORTUNITY

A patent has been filed protecting the concept, a range of enzymes and photocatalysts, and an integrated single reactor for carrying out both the enzymatic degradation and the photoreforming steps. The patent also covers photoreforming with CO_2-to-syngas production instead of hydrogen evolution, which has been

demonstrated as an additional proof-of-concept with this work. The inventors are interested in speaking with interested industrial parties who feel able to accelerate the commercialisation of the technology.

INVENTORS

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The Reisner laboratory develops new concepts and technologies for the conversion of solar energy and renewable electricity into sustainable fuels and chemicals for a circular economy. Central themes of our cross-disciplinary and collaborative approach are the development of processes for the upcycling of plastic and biomass waste as well as the use of carbon dioxide and water to produce green fuels and chemicals for a sustainable future.

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PATENT

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