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Photocatalytic reforming of biomass for sustainable hydrogen production

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The increasing need to address climate change and reduce the global reliance on fossil fuels has intensified the search for sustainable and environmentally friendly energy alternatives. In this context, the development of clean fuels is a key strategy for achieving carbon neutrality and promoting a more sustainable energy matrix. Hydrogen (H_2) has attracted significant attention due to its high energy density and versatility, especially in applications such as transportation and energy storage. Despite its potential, conventional H_2 production methods, most notably steam methane reforming, remain problematic as they are associated with high energy demands and considerable CO_2 emissions.
Photocatalysis using biomass waste emerges as an innovative and promising approach, as biomass acts as a sacrificial agent, enhancing H_2 production.[1] To optimize the photocatalytic process, a low loading (1.0 %w/w) of platinum (Pt) was introduced onto the optical semiconductor graphitic carbon nitride (GCNT) via the incipient wetness impregnation method. This material is particularly notable due to its ability to be photoactivated within the visible range of the electromagnetic spectrum, which is a requirement for solar-driven technologies.[2]
Various types of biomass waste, including banana peel, orange peel, lemon peel, lemon tree leaves, daisy flowers, grass, corncob, and waste coffee grounds, were evaluated to identify their potential for H_2 generation. Among the tested feedstocks, banana peel waste proved to be the most efficient, yielding approximately 63 μmol of H_2 after 120 min of reaction. Samples of the aqueous phase were collected before and after the photocatalytic process, and high-performance liquid chromatography analysis indicated that the sugars consumed during the reaction were fructose and glucose. The results suggest that these sugars play a crucial role by acting as hole scavengers in the H_2 production process.
In addition to the use of biomass waste, other traditional sacrificial agents were tested to further enhance H_2 evolution, including triethanolamine (TEOA), methanol, formic acid, lactic acid, citric acid, and sodium sulfide. Among these, TEOA exhibited the highest efficiency, resulting in a H_2 yield of 390 μmol after 120 min of reaction. This finding highlights the potential of TEOA as an effective hole scavenger in photocatalytic systems aimed at enhanced hydrogen production.

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