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Hydrogen production by photoreforming using different TiO_2 or Nb_2O_5 composites with graphene or graphene oxide as photocatalysts.

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The photoreforming of aqueous solutions containing organic compounds combines the photocatalytic splitting of water with the oxidation of organics in a single process under ambient conditions. TiO_2 and Nb_2O_5 suffer from limited absorption of sunlight due to their large bandgap (~ 3 eV) and low photocatalytic activity due to the rapid recombination of charge carriers. Various strategies have been employed to solve these problems, and the combination of TiO_2 nanoparticles (NPs) with carbon nanomaterials, such as carbon nanotubes, graphite oxide (GO) and graphene (G), has been proposed as a suitable method to increase photocatalytic activity. From previous work, we have seen that home-made Nb_2O_5 ¹ from ANbO (Ammonium Niobium Oxalate) is an excellent catalyst that has activity comparable to that of TiO_2 .

This research focuses on the development of hetero-junctions synthesized with different weight ratios between carbon materials (5, 10 or 20 %) and TiO_2 (named Ti-G 10:X or Ti-GO 10:X, where X represent the mass of G or GO per 10 g of TiO_2) or Nb_2O_5 (named Nb-G 10:X or Nb-GO 10:X, where X represent the mass of G or GO per 10 g of Nb_2O_5) for the photo-reforming of organics dissolved in water ². In these composites, the oxide semiconductor acts as the photocatalyst, while the carbon materials (commercial or homemade) act as a reservoir and electron carrier, facilitating the transfer of electrons to the reaction sites. Photoreforming tests of water solutions of ethanol or glycerol or water dispersion of microplastics were conducted both under UV and natural sunlight irradiation. The activity of the catalysts was compared based on the amount of hydrogen produced. The catalysts were tested without and with the use of platinum as co-catalyst. In the first case, small amounts of hydrogen were obtained. The best result was obtained in the presence of Ti-G 10:1 with 1wt% of Pt reaching a productivity of $311 \text{ mmol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$ (AQE of 100 %) under UV light and $13 \text{ mmol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$ under natural sunlight.

References

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