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Nb₂O₅ and its composites with C₃N₄, TiO₂ and graphene as photocatalysts in aqueous solution for the generation of H₂ by photoreforming

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Hydrogen is a versatile energy carrier in the context of decarbonisation and the energy transition towards renewable sources. Photoreforming of aqueous solutions containing organic compounds is a process that combines the generation of hydrogen from water and the oxidation of an organic substrate in a single process occurring under ambient conditions.¹

In the present research, a series of photocatalysts based on the semiconductor Nb₂O₅ have been prepared and tested for the non-selective photoreforming of ethanol, used as a sacrificial reagent in water. The ammonium niobium oxalate complex was transformed through a hydrothermal process, lasting from 1 to 4 days, into Nb₂O₅. The composites were also obtained in the presence of C₃N₄ prepared from melamine and with commercial TiO₂ and graphene.

The activity of the materials was measured as a function of the amount of H₂ produced under UV irradiation or natural sunlight. Pure Nb₂O₅ are active, obtaining a maximum of 60 mmol·g⁻¹ h⁻¹ of H₂ for the catalyst prepared after 3 days in the autoclave. The presence of TiO₂ along with Nb₂O₅ improves the activity of the oxide, however the presence of graphene or C₃N₄ does not influence the reaction. The maximum activity was achieved with the Nb₂O₅-TiO₂ composite prepared after 3 days of hydrothermal treatment, resulting in the formation of 120 mmol·g⁻¹ h⁻¹ of H₂ with an apparent quantum yield of ca. 37% using UV LED light at 365 nm. The activity decreases to 11 mmol·g⁻¹ h⁻¹ of H₂ under solar radiation. The TiO₂-graphene composite is the one that shows the best productivity, obtaining 300 mmol·g⁻¹ h⁻¹ of H₂.

References

¹ García-López, E.I.; Genco, A.; Lagostina V.; Paganini M.C; Marci G. *Catalysis Today*, **2023**, 423, 114283.