

Solar Polygeneration Collector for Combined Heat, Power, Hydrogen Fuel and Wastewater Treatment



Development of nanostructured sustainable photocatalysts for industrial wastewater remediation with co-generation of H₂

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Public Executive Summary

The SPECTRUM project aims to design, develop, prototype, and test lab-scale solar collectors that effectively utilize the entire solar spectrum to cogenerate heat, electricity and hydrogen using industrial wastewater. This report presents the results of the activities developed in *Task 1.2 Development of nanostructured low cost and sustainable photocatalysts* of SPECTRUM's Work Package 1, *Optimization of the photocatalytic process of wastewater treatment and hydrogen generation*.

One of the Specific Objectives (SO1) of the SPECTRUM project is to develop low cost and sustainable nanostructured photocatalysts for synergetic pollutants degradation and H₂ generation. With this goal, nanostructured titanium dioxide (TiO₂) photocatalysts were developed using copper as an efficient and economical co-catalyst, suitable for large-scale hydrogen production systems. Two series of copper-decorated TiO₂ photocatalysts were synthesized, one based on TiO₂ nanoparticles (NP) (Series I) and another based on TiO₂ nanotubes (NT) (Series II).

Copper-decorated TiO₂ NP and NT with different Cu weight percent were prepared by chemical reduction method, a mild process performed under ambient temperature and atmospheric pressure. The structure, morphology, composition and optical properties of synthesized photocatalysts (series I and II) were investigated through joint efforts from LNEG and UNIBO, using different techniques: X-ray Diffraction spectroscopy (XRD), Transmission Electron Microscopy (TEM), Scanning Electron Microscope (SEM), Energy Dispersive X-ray spectroscopy (EDS), X-ray Photoelectron Spectroscopy (XPS) Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) and ultraviolet-visible spectroscopy (UV-Vis).

All synthesized photocatalysts present well-dispersed Cu nanoparticles ($\approx 2\text{--}3$ nm) on the TiO₂ surface which can improve photocatalytic H₂ generation mainly because they maximize useful Cu-TiO₂ interfacial sites while minimizing loss pathways.

All photocatalyst were tested for hydrogen production under *Task 1.3 Optimization of photocatalytic H₂ production process at lab scale*, and results were used to propose further modifications on photocatalysts design in an interactive process.