

Highly active catalysts (Ni, Pt) supported on strontium titanate (SrTiO₃) for hydrogen evolution

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A critical point as far as energy consumption is concerned has been reached, thus clean and renewable energy sources are of paramount importance in order to meet the needs of the overgrown population. Photocatalytic water splitting is a safe and cost-effective way of converting solar energy into chemical fuels. Hydrogen (H₂) is thought of as a potentially important fuel because it is non-toxic, has high gravimetric energy density (~142 MJ/Jg) and can be produced utilizing renewable resources such as sunlight and water. In this regard, the research and development of robust and highly active semiconductor photocatalysts are of vital importance. Perovskite-type SrTiO₃ (STO) has been extensively studied as a photocatalytic water splitting semiconductor since it has a suitable conduction band edge position for water reduction and H₂ production. Furthermore, recent research has shown that the presence of co-catalysts such as metallic nanoparticles on the surface of STO is crucial to inhibit charge carrier recombination and improve photocatalytic hydrogen generation performance.^[1] More specifically, at the metal/semiconductor interface, a Schottky barrier is created that is responsible to assist transportation of electrons from the semiconductor to metal co-catalyst, which acts as an electron trap leading to improved H₂ evolution.

In this work, STO was successfully synthesized through hydrothermal polyol process and nanoparticles of Ni and Pt were deposited on its surface via a photochemical deposition method. A series of Pt and Ni-decorated STO materials with different wt% of metal loadings were synthesized. SEM and TEM images revealed the morphology of the prepared materials as well as the size of the deposited Ni and Pt nanoparticles. Moreover, UV-vis spectroscopy highlights the enhancement in the absorption towards the visible region of the spectrum. Photocatalytic experiments for hydrogen evolution were performed in an airtight Pyrex glass reactor using a 300 W Xe lamp as the irradiation source. The evolved gas was analysed using a gas chromatograph equipped with a thermal conductivity detector. The catalytic results indicated that the Pt/STO catalyst with 0.1% Pt reached a rate of 294 $\mu\text{moles h}^{-1}$ whereas the sample with a 0.25% Ni loading reached a rate of 63 $\mu\text{moles h}^{-1}$ for H₂ evolution, demonstrating a 14x and 3x times enhancement in photocatalytic performance, respectively, compared to the pristine STO sample (21 $\mu\text{moles h}^{-1}$).

References

[1] I. Tamiolakis *et al.*, “Mesoporous implantable Pt/SrTiO₃:C,N nanocuboids delivering enhanced photocatalytic H₂-production activity via plasmon-induced interfacial electron transfer”, *Appl. Catal. B Environ.*, 2018, 236, 338–347.

Acknowledgements

This research work was supported by the “Water2Hy” program titled “A novel and rational design of surface and interface oriented heterostructures for sustainable solar-driven photocatalytic hydrogen conversion” part of the Bilateral and Multilateral S&T Cooperation Greece-China (Code: T7ΔKI-00369).