Solar photocatalytic H_2 production over CeO_2-based catalysts

Stefano Andrea Balsamo[1], Roberto Fiorenza[1], Marcello Condorelli[1], Luisa D'Urso[1], Giuseppe Compagnini[1], and Salvatore Sciré[1]. (1) Dipartimento di Scienze Chimiche, Università degli studi di Catania, Catania, Italia
e-mail: stefano.balsamo@phd.unict.it

Introduction and Methods

Photocatalytic approach is a green and alternative process to produce hydrogen via water splitting[1]. In photocatalysis, CeO_2 is a less active semiconductor than TiO_2 (the most used photocatalyst), but its lower band gap allows it to adsorb a major portion of visible light[1]. One of the most employed strategy for this purpose, is the synthesis of nanocomposites with other oxides. WO_3 is widely used as holes donor in water splitting processes and its combination with CeO_2 could be a suitable strategy to increase the H_2 yield[2]. Recently, the photo-reforming process of an organic compound is also considered as a good approach[3], and that is why in the reaction mixture an alcohol is often added as sacrificial agent[3]. In this context, the use of a bio-alcohol could be an additional advantage. In this work, were synthesized several composites using two different preparation methods: co-precipitation and templated synthesis. In particular, were employed two different templating agents, the cetrimonium bromide (CTAB) and the hexamethylenetetramine (HMTA). For each preparation, a 5% wt and 10% wt of tungsten oxide were added, for a total of six different samples. Finally, the most performant sample were treated with a pulsing laser, in order to modify its surface properties.

Results

In the results, it is possible to note how a low percentage of WO_3 enhances the activity in co-precipitated samples (CeO_2-W5) respect to bare CeO_2. However, this behaviour is opposite in HMTA templated synthesis, where the best activity among all untreated composites is given by the 10% modified sample (CeO_2-W10 [HMTA]). Instead, CTAB preparation shows the lowest activity. Looking the treated samples, it is interesting as the laser treatment enhances the activity more in the composite than in the bare sample.

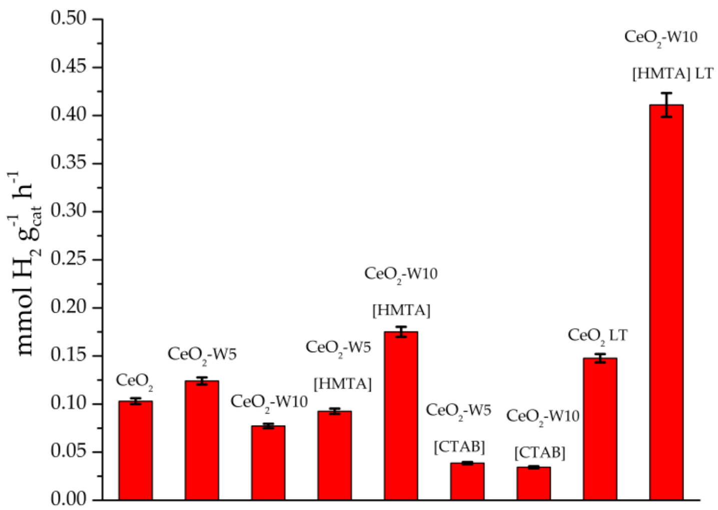

Figure 1 H_2 production for each sample

Conclusion

CeO_2-WO_3 composites were prepared as unconventional photocatalysts for hydrogen evolution. The 10% wt HMTA templated synthesis gave the best results with 0.175 mmol/g h of H_2. Furthermore, the laser treatment induces defective centres on the material surface that increase the H_2 yield more than two times (0.4 mmol/g h), how verified also by Raman spectroscopy and TEM images.

References

1. Fiorenza, R. *et al.* Au/TiO2-CeO2 catalysts for photocatalytic water splitting and VOCs oxidation reactions. *Catalysts* **6**, 121 (2016).

2. Su, J., Guo, L., Bao, N. & Grimes, C. A. Nanostructured WO 3 /BiVO 4 Heterojunction Films for Efficient Photoelectrochemical Water Splitting. *Nano Lett.* **11**, 1928–1933 (2011).

3. Bowker, M. *et al.* The photocatalytic window: Photo-reforming of organics and water splitting for sustainable hydrogen production. *Catal. Letters* **145**, 214–219 (2015).