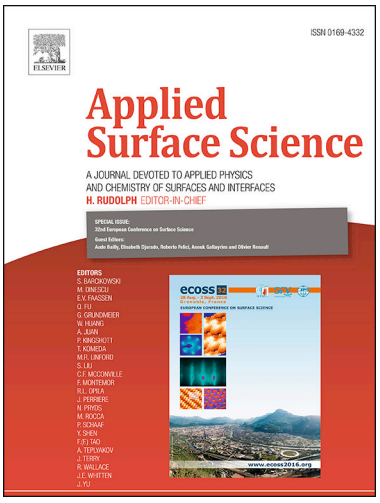
Accepted Manuscript




Full Length Article

# *In situ* attenuated total reflection infrared spectroscopy study of the photocatalytic steam reforming of methanol on $Pt/TiO_2$

Gian Luca Chiarello, Davide Ferri, Elena Selli

PII: S0169-4332(18)31138-3
DOI: https://doi.org/10.1016/j.apsusc.2018.04.167
Reference: APSUSC 39166

To appear in: *Applied Surface Science*

Received Date: 20 October 2017
Revised Date: 3 April 2018
Accepted Date: 17 April 2018

Please cite this article as: G. Luca Chiarello, D. Ferri, E. Selli, *In situ* attenuated total reflection infrared spectroscopy study of the photocatalytic steam reforming of methanol on $Pt/TiO_2$, *Applied Surface Science* (2018), doi: https://doi.org/10.1016/j.apsusc.2018.04.167

# *In situ* attenuated total reflection infrared spectroscopy study of the photocatalytic steam reforming of methanol on $Pt/TiO_2$

Gian Luca Chiarello[a,*], Davide Ferri[b], Elena Selli[a]

[a]*Dipartimento di Chimica, Università degli Studi di Milano, Via Golgi 19, I-20133 Milano, Italy*

[b]*Paul Scherrer Institut, CH-5232 Villigen, Switzerland*

## ABSTRACT

The effect of Pt deposition on $TiO_2$ and of Pt particle size on the photocatalytic steam reforming of methanol was studied by *in-situ* attenuated total reflectance infrared spectroscopy (ATR-IR). Two 0.5 wt.% $Pt/TiO_2$ samples were investigated, one possessing Pt nanoparticles of *ca.* 4 nm mean size, the other Pt clusters of *ca.* 1.3 nm mean size showing significantly different photoactivity in terms of both hydrogen production rate and selectivity to CO, $CO_2$ and all other by-products. The presence of Pt nanoparticles strongly affects both the adsorption/desorption and the reactivity properties of the $TiO_2$ surface. Moreover, the variation of the IR spectrum background upon UV-vis irradiation proved that the photopromoted electrons can be trapped by the Pt particles with the consequent increasing of electron-hole separation. Reducing the Pt size from nanoparticles to clusters increases the rate of methanol and water absorption and hinders the detrimental formation of irreversibly adsorbed CO on Pt. All of these aspects contribute to increase the photocatalytic performance of Pt cluster-decorated $TiO_2$ with respect to Pt nanoparticles containing $TiO_2$. Finally, prolonged exposure of all samples to methanol/water vapour in the dark led to the formation of unreactive formate which persists also under UV-vis irradiation. By contrast, this spectator species does not form when the sample is exposed to methanol/water vapour under UV-vis irradiation.

***Keywords*:** Photocatalytic hydrogen production, *in situ* ATR-IR, flame spray pyrolysis, Pt clusters

.

* Corresponding author. Tel: +39 02 503 14281; fax: +39 02 503 14300.
*E-mail address:* gianluca.chiarello@unimi.it