

# Au/Ga<sub>2</sub>O<sub>3</sub> photocatalysts for methane conversion coupling with hydrogen evolution from water

Eliane Ribeiro Januario<sup>1</sup>, Jorge Moreira Vaz<sup>1</sup>, Estevam Vitorio Spinacé<sup>1</sup>

<sup>1</sup>Instituto de Pesquisas Energéticas e Nucleares (*Células a Combustível e Hidrogênio*)

*e-mail: eliane.quimica@gmail.com*

Methane is a major constituent of natural gases and is an important source of carbon and hydrogen for the chemical industry. However, methane is one of the most stable molecule and high reaction temperatures are required to transform methane into more valuable and useful chemicals [1]. The use of solar energy and a photocatalyst would be an ideal method to convert methane in milder conditions.[1] Recently, it was reported the direct combination of hydrogen evolution from water and the methane conversion in a photocatalytic system over Pt/TiO<sub>2</sub>. [2] In this study, we investigated the use of β-Ga<sub>2</sub>O<sub>3</sub> loaded with different amounts of Au nanoparticles (0.1-1.0%) as photocatalysts that were prepared by impregnation of HAuCl<sub>4</sub> solution onto a commercial β-Ga<sub>2</sub>O<sub>3</sub> and reduction at 200 °C under hydrogen flow. The photocatalysts were characterized by X-ray diffraction (XRD), UV-Vis spectroscopy, Transmission Electron Microscopy (TEM), and Raman Spectroscopy. The photocatalytic reactions were performed on a commercial Ace photocatalytic reactor equipped with a mercury lamp (450W, UV/A/B/C). A steady stream of methane gas was bubbled into water containing the photocatalyst in suspension and the products were identified by GC-MS and quantified by GC-FID/TCD using calibration curves. The principal products formed were C<sub>2</sub>H<sub>6</sub>, CO<sub>2</sub>, and H<sub>2</sub> with minor quantities of C<sub>2</sub>H<sub>4</sub>, C<sub>3</sub>H<sub>8</sub>, C<sub>4</sub>H<sub>10</sub>, and CO. The best performance was observed for the photocatalyst prepared with 0.1% of Au that produced 129 μmol.g<sub>cat</sub><sup>-1</sup>h<sup>-1</sup> of C<sub>2</sub>H<sub>6</sub> and 10,062 μmol.g<sub>cat</sub><sup>-1</sup>h<sup>-1</sup> of H<sub>2</sub>.

## References

- [1] E.R. Januario, P.F. Silvaino, A.P. Machado, J.M. Vaz, E.V. Spinace, "Methane Conversion Under Mild Conditions Using Semiconductors and Metal-Semiconductors as Heterogeneous Photocatalysts: State of the Art and Challenges". *Front. Chem.*(2021)9:685073
- [2]. L.Yu, Y. Shao, D. Li, "Direct combination of hydrogen evolution from water and methane conversion in a photocatalytic system over Pt/TiO<sub>2</sub>". *Appl. Catal.B:Envir.* (2017)204:216