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Authors: Diego Mateo, Josep Albero, Hermenegildo García

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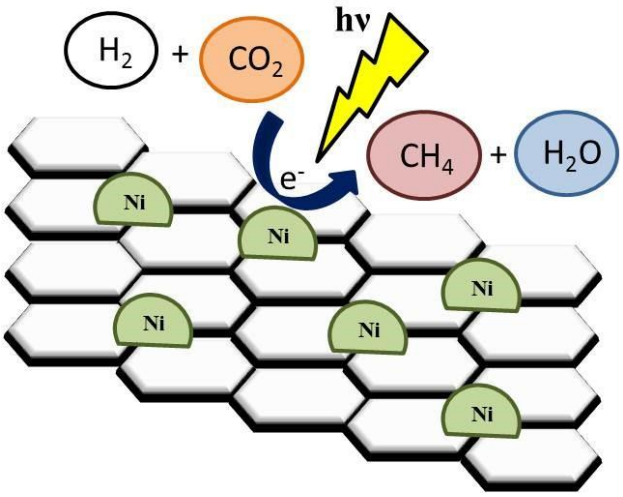
# Graphene supported NiO/Ni nanoparticles as efficient photocatalyst for gas phase $CO_2$ reduction with hydrogen

Diego Mateo[a], Josep Albero[a] and Hermenegildo García[a,*]

[a] *Instituto de Tecnología Química, Universitat Politècnica de València-consejo Superior de Investigaciones Científicas, Avenida de los Naranjos s/n, 46022 Valencia, Spain*

*** Corresponding author.** Tel: +34 96 387 7807; Fax: +34 96 387 7809; E-mail: hgarcia@qim.upv.es

Graphical abstract




Highlights

- Ni nanoparticles supported on graphene form spontaneously a thin layer of NIO
- NiO/Ni on graphene promotes photoassisted $CO_2$ methanation at 642 µmol/g·h at 200 ºC
- The process can be carried out under continuous flow at rates 244.8 µL · $h^{-1}$
- The presence electron donors increases the rate of the photoassisted methanation
- Nitrobenzene quenches methanation, supporting charge separation

## Abstract

The photocatalytic activity of NiO/Ni nanoparticles (NPs) supported on defective graphene (NiO/Ni-G) has been tested for the photoassisted $CO_2$ reduction with $H_2$. NiO/Ni-G was prepared by $H_2$ reduction of $NiCl_2$ adsorbed on few-layers defective G and storage under air. An optimal Ni loading of 23 wt% was found, reaching the maximum specific $CH_4$ formation rate (642 µmol $CH_4$ · $g_{Ni}^{-1}$ · $h^{-1}$ at 200 ºC) and quantum yield of 1.98 %. Under the same conditions Ni NPs supported on silica-alumina or NiO NPs exhibit notably lower specific $CH_4$ production rates than NiO/Ni-G. It was found that $H_2O$ formed in the reaction has a detrimental influence on the photocatalytic activity and evidence supports that $H_2O$