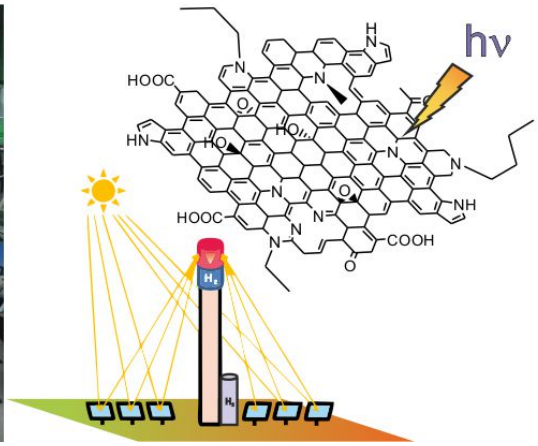
UABDIVULGA
BARCELONA RECERCA I INNOVACIÓ

13/04/2018

Graphene-based photocatalysts to obtain hydrogen



Graphene-based materials are an efficient, cheap, abundant and non-toxic alternative for catalysing the obtaining of hydrogen, which can be used as a removable fuel, through the photoinduced water splitting. A group from the Instituto de Ciencias de los Materiales (ICMAB) has developed, based on laser technology, a nitrogen-doped graphene powder material in different experimental conditions for different catalytic functions through the process, in a simple, versatile and scalable to industry way

The enormous amount of energy consumed by actual society, mainly based on fossil fuels, is provoking an unprecedented impact in the biosphere. Therefore, it is imperious to substitute conventional energy sources by sustainable technologies. A promising alternative consists in the use of hydrogen as renewable fuel through the photoinduced water splitting by means of solar radiation and semiconductor photocatalysts.

A great diversity of catalysts are being investigated, where titanium dioxide (TiO_2) is one of the most studied ones due to its low toxicity, stability, abundance and low cost. Catalytic systems normally use cocatalysts composed by noble metals or rare earths for improving the efficiency. However, it has to take into account that many of these materials are scarce and have skyrocketing prices. For this reason, great research efforts are being carried out for finding

abundant and cheap materials working as high performance catalysts.

An interesting alternative to traditional catalytic materials consists in using carbon material, since it is an abundant element, cheap and non-toxic. In particular, materials based on graphene, a 2-dimensional allotrope of carbon, have awaken great expectative due to their excellent physicochemical properties. Many studies demonstrate that nitrogen-doped graphene-based materials can exhibit high photocatalytic efficiency and are steady candidates to be used in water splitting generation of hydrogen.

In our study, we used a methodology based on laser technology for the fabrication of nitrogen-doped graphene powder material in a simple, versatile and scalable to industry way. The method consists in the irradiation with ultraviolet laser pulses of aqueous dispersions of graphene oxide sheets and ionic liquid based on imidazole molecule. The laser radiation induces complex chemical reactions between the functional groups of graphene oxide and the adjacent imidazole molecules, leading to their structural transformation. In this way, the deoxidation of the graphene oxide sheets as well as their doping with different nitrogen functionalities (graphitic, pyridinic and pyrrolic) are achieved. Once the irradiation process is finished, the dispersed powder is filtered and dried, being ready for its use as photocatalyst.

We have analysed the activity of the materials obtained with different experimental conditions for the generation of hydrogen by water splitting and we have observed that graphene with larger proportion of graphitic nitrogen show potential as photocatalyst, whereas the graphene material with larger amount of pyridinic nitrogen exhibits significant synergy with TiO_2 nanoparticles, acting as cocatalyst.

Dr. Angel Pérez del Pino
Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)
aperez@icmab.es

References

Angel Pérez del Pino, Arántzazu González-Campo, Sandra Giraldo, José Peral, Enikö György, Constantin Logofatu, Andrew J. deMello, Josep Puigmartí-Luis, **Synthesis of graphene-based photocatalysts for water splitting by laser-induced doping with ionic liquids**, *Carbon,Volume 130,2018,Pages 48-58,ISSN 0008-6223*,https://doi.org/10.1016/j.carbon.2017.12.116.

View low-bandwidth version