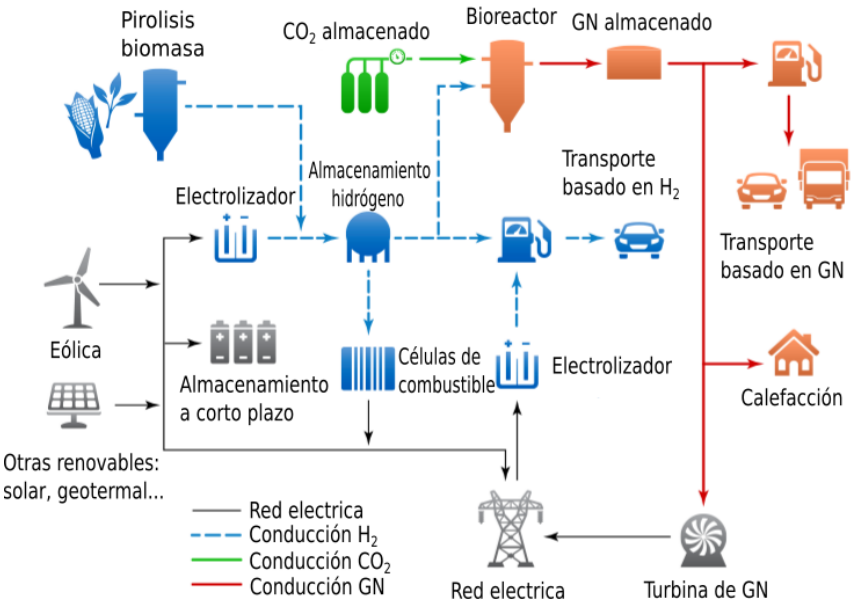
Estudio físico químico de oxinitruros, nitruros y óxidos de metales de transición para fotoelectrolisis del agua

Autor: Alfredo Giner Requena
alfredo.giner@ua.es

Directora: Teresa Lana Villareal
Mentor: Roberto Gómez Torregrosa

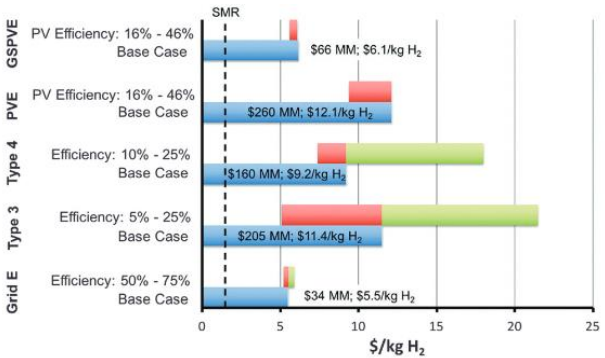
H_2 verde y celdas fotoelectroquímicas

120 000 TW

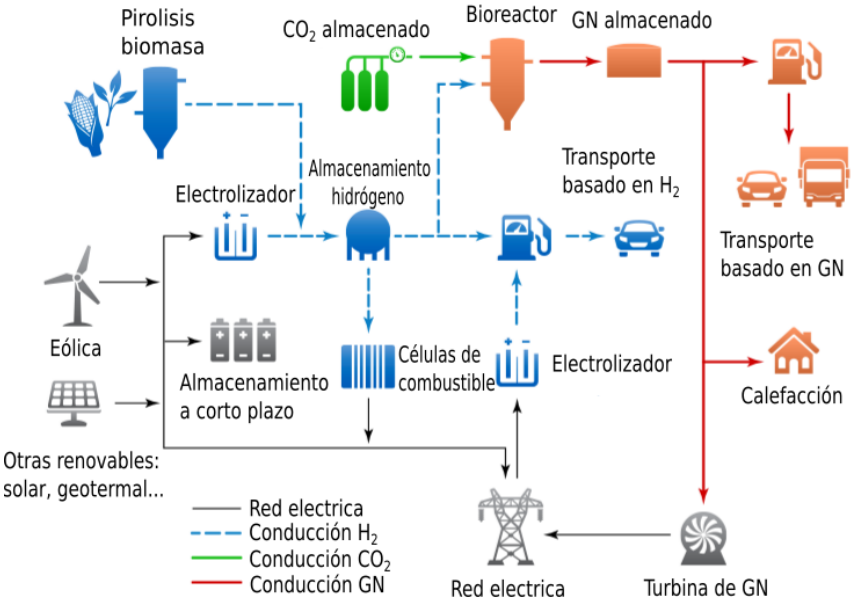


Renewable Electrolysis. (2022). Retrieved 19 June 2022, from https://www.nrel.gov/hydrogen/renewable-electrolysis.html

H_2 verde y celdas fotoelectroquímicas

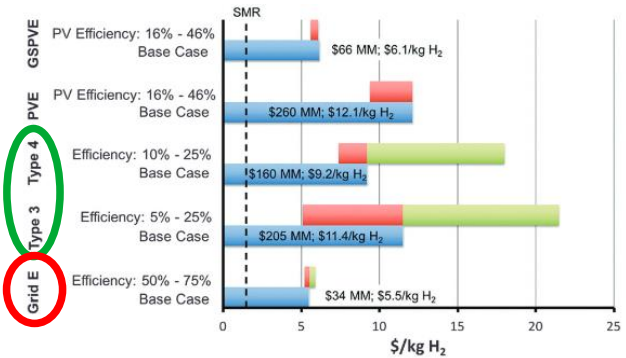


SHANER, Matthew R., et al. A comparative technoeconomic analysis of renewable hydrogen production using solar energy. Energy & Environmental Science, 2016, vol. 9, no 7, p. 2354-2371.

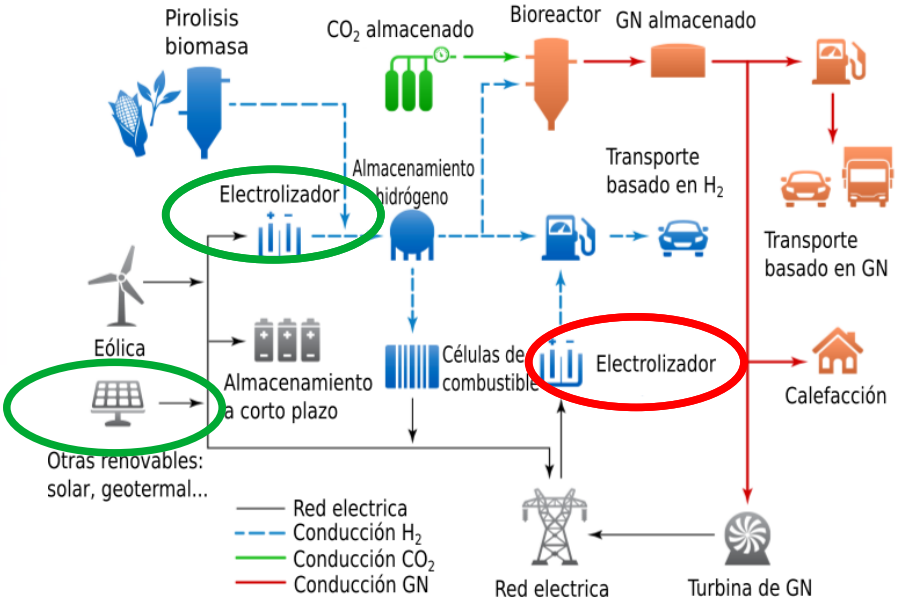


Renewable Electrolysis. (2022). Retrieved 19 June 2022, from https://www.nrel.gov/hydrogen/renewable-electrolysis.html

H_2 verde y celdas fotoelectroquímicas



SHANER, Matthew R., et al. A comparative technoeconomic analysis of renewable hydrogen production using solar energy. Energy & Environmental Science, 2016, vol. 9, no 7, p. 2354-2371.



Renewable Electrolysis. (2022). Retrieved 19 June 2022, from https://www.nrel.gov/hydrogen/renewable-electrolysis.html

¿Por qué óxidos y oxi/nitruros?

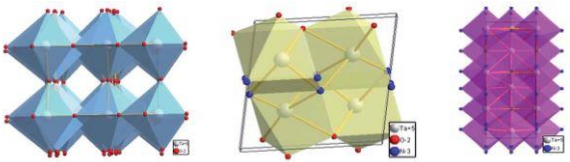
Óxidos

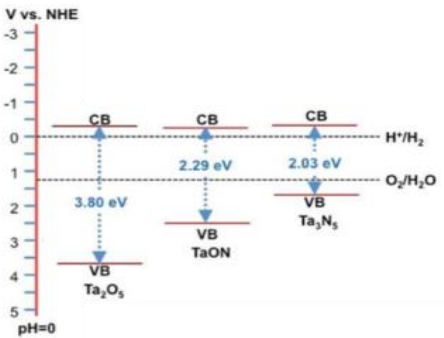
Fe_2O_3, Cu_2O, TiO_2, WO_3...

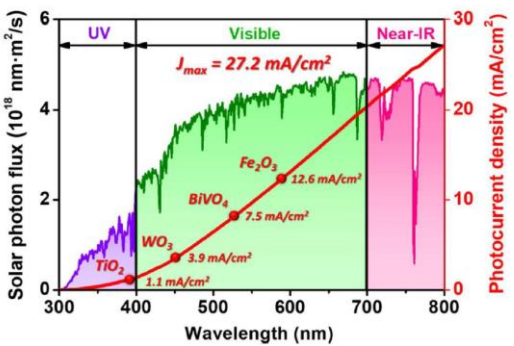
Se estiman mas de 200,000 óxidos ternarios

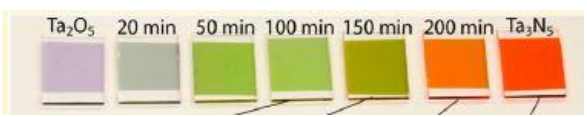
Perovskitas y espinelas

Oxi/nitruros









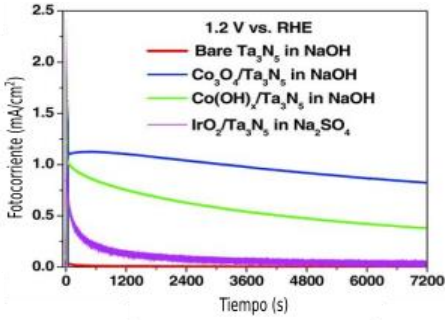
ADHIKARI, Shiba P., et al. Visible light assisted photocatalytic hydrogen generation by Ta 2 O 5/Bi 2 O 3, TaON/Bi 2 O 3, and Ta 3 N 5/Bi 2 O 3 composites. RSC Advances, 2015, vol. 5, no 68, p. 54998-55005.

Oxi/nitruros estudiados

Material	Fotocorriente (mA/cm² 1,23 V RHE)
$LaTiO_2N$	4,17
$LaTaO_2N$	0,148; 0,12
CaTaON	0,024
BaTaON	6,5; 3,01; 2,0
$ZnTaO_2N$	2,3
$BaNbO_2N$	2,2; 0,53
$SrTaO_2N$	0,27
$SrNbON_2$	1,5; 1,28
NbON	0,6
TaON	4,36; 3,8
Ta_3N_5	4,5; 3,18

Problemas:

1 - Estabilidad



LIAO, Maijia, et al. Co3O4 nanoparticles as robust water oxidation catalysts towards remarkably enhanced photostability of a Ta3N5 photoanode. Advanced Functional Materials, 2012, vol. 22, no 14, p. 3066-3074.

2 – Síntesis

- (Polvo) Altas temperaturas, tiempos largos y NH_3 gas

- Electroforesis

- Modificaciones superficiales

Óxidos ternarios

Espinelas:

Ferritas

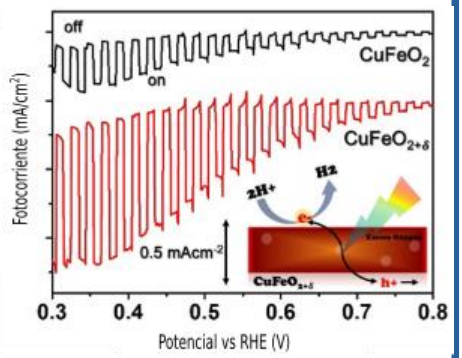
$CaFe_2O_4$
$CuFe_2O_4$
$NiFe_2O_4$
$CoFe_2O_4$

Cromitas

$CuCr_2O_4$
$FeCr_2O_4$
$NiCr_2O_4$
$CoCr_2O_4$

Otros

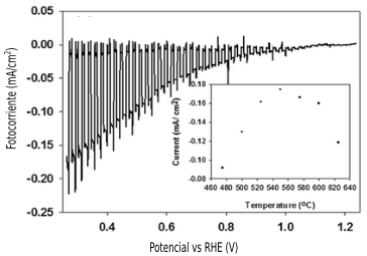
$FeCo_2O_4$
$CuMn_2O_4$
$MgMn_2O_4$



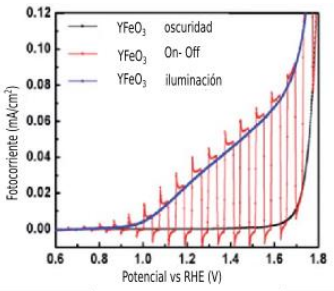
JANG, Youn Jeong, et al. Oxygen-intercalated CuFeO2 photocathode fabricated by hybrid microwave annealing for efficient solar hydrogen production. Chemistry of Materials, 2016, vol. 28, no 17, p. 6054-6061.

Perovskitas:

$LaCoO_3$
$LaMnO_3$
$LaFeO_3$
$NdFeO_3$
$BiFeO_3$
$FeTiO_3$
$NiTiO_3$
$YFeO_3$



PAWAR, Govinder S.; TAHIR, Asif A. Unbiased spontaneous solar fuel production using stable LaFeO3 photoelectrode. Scientific reports, 2018, vol. 8, no 1, p. 1-9.



GUO, Yongsheng, et al. A novel wide-spectrum response hexagonal YFeO 3 photoanode for solar water splitting. RSC advances, 2017, vol. 7, no 30, p. 18418-18420.

Objetivos

Investigar y optimizar los métodos de síntesis

Caracterizar (foto)electroquímicamente los materiales

Modificar mediante distintas técnicas los materiales mas interesantes

Integrar los mejores electrodos en células fotoelectroquímicas a escala laboratorio

Metodología

Caracterización química:

Composición:

DRX, XPS, Espectroscopia Raman e ICP

Morfología y topografia:

SEM, TEM y AFM

Otras:

TAS, Sonda de Kelvin, espectroscopia IR y UV-Vis, cromatografía de gases, etc...

Caracterización electroquímica:

En celda de tres electrodos:

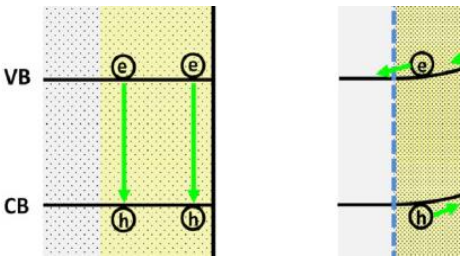
- Voltametría cíclica
- Voltametría lineal con iluminación transitoria
- Espectroscopia de impedancias
- Cronoamperometrías

En celda de dos electrodos:

- Curvas j-E
- Seguimiento de gases (H_2 y O_2)
- Espectroscopia de impedancia
- Cronoamperometrías

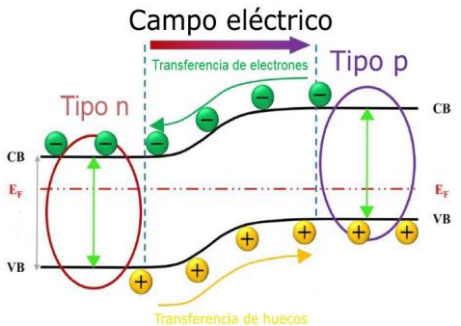
Metodología

Dopado



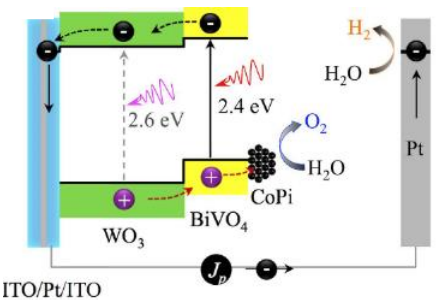
Zhang, Z. y Yates Jr, J. T. Chemical reviews 2012, 112, 5520-5551.

Capas extractoras y protectoras



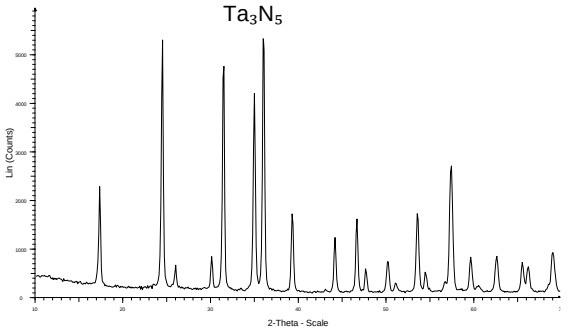
Yang, J.-X.; Meng, Y.; Tseng, C.-M.; Huang, Y.-K.; Lin, T.-M.; Wang, Y.-M.; Deng, J.-P.; Wu, H.-C. y Hung, W.-H. Nanoscale research letters 2020, 15, 1-7.

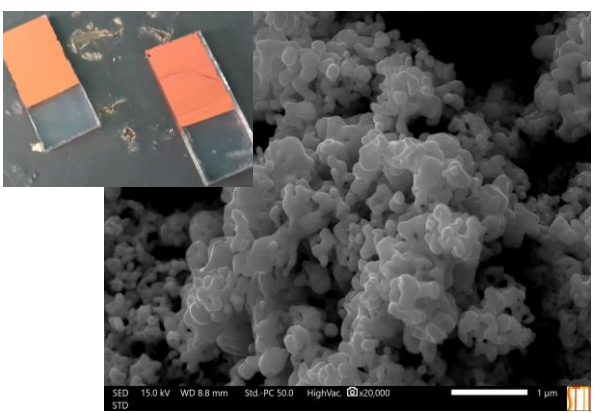
Cocatalizadores



PIHOSH, Yuriy, et al. Photocatalytic generation of hydrogen by core-shell WO3/BiVO4 nanorods with ultimate water splitting efficiency. Scientific reports, 2015, vol. 5, no 1, p. 1-10.

¿Algún resultado hasta ahora?





Estamos optimizando las condiciones de síntesis