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Hybrid Organic Inorganic Photoanodes Based on Conjugated Porous Polymers Prepared by Electropolymerization

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Abstract

Artificial photosynthesis by photoelectrocatalysis is one of the most promising waysto store solar energy in the form of fuels, thus constituting a sustainable alternative to fossil fuels. The photoelectrodes used in this technique have to be designed according to the optoelectronic properties of their components in order to direct charge carriers to the reaction sites (minimizing electron-hole recombination), increase light absorption and/or promote catalysis on their surface.1,2 Conjugated polymers (CPs) are used as part of some photoelectrodes due to their good conductivity and the possibility to tailor their optoelectronic properties at the molecular level. Some of the most used CPs, such as PEDOT, have a linear structure; which makes them easy to process as thin films, but also unstable under UV illumination if they are in contact with water.3 This fact limits their use to buried junctions in well protected photoelectrodes. On the other hand, Conjugated Porous Polymers(CPP)3–5 show higher stability due to their 3D structure, which makes them promising and still untapped materials for artificial photosynthesis. However, it is difficult to produce thin films with them by conventional methods such as drop casting or spin coating because of their morphology. Thanks to the electropolymerization process, we are able to prepare homogeneous, transparent and light-absorbing CPP films both on conducting glass substrates and on inorganic semiconductors such as BiVO4 or TiO2. One of these CPPs, IEP-19, has been synthesized for the first time and it shows promising photocurrents, which are significantly higher than those of a previously known CPP with a similar structure: CPP-3TB. Moreover, hybrid photoanodes where the CPP is electropolymerized on top of the inorganic semiconductor present higher photocurrents than the semiconductors alone, showing a synergistic effect between the organic and inorganic semiconductors. In order to further improve the photoresponse of the hybrid photoanodes, samples with different oxide thicknesses where studied. Finally, optimal thicknesses were reached. All these results will be explained according to the optical, photoelectrochemical and morphological properties of the photoanodes

Speaker Publications:

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2. van de Krol, R. & Grätzel, M. *Photoelectrochemical Hydrogen Production*. (2012). doi:10.1007/978-1-4614-1380-6
3. Liras, M., Barawi, M. & de la Peña O'Shea, V. A. Hybrid materials based on conjugated polymers and inorganic semiconductors as photocatalysts: from environmental to energy applications. *Chem. Soc. Rev.* **48**, 5454–5487 (2019).
4. López-Calixto, C. G. *et al.* Conjugated porous polymer based on BOPHY dyes as photocatalyst under visible light conditions. *Appl. Catal. B Environ.* **258**, 117933 (2019).
5. Gu, C. *et al.* π-Conjugated Microporous Polymer Films : Designed Synthesis , Conducting Properties , and Photoenergy Conversions. *Angew. Chem. Int.* **54**, 13594–13598 (2015)

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