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Cell and electrode design for the sustainable production of H2 using the Photo-Electrochemical Cell (PEC) approach

Abstract:

As reported from the Net Zero Emission Roadmap (NZE) from the International Energy Agency (IEA), the demand for hydrogen reached 95Mt in 2022. Most of this production still comes from fossil fuels with just 1Mt produced from water electrolysis or fossil fuels linked to a carbon capture and storage system (CCS) [1]. In the NZE scenario, the request for low-emission hydrogen would reach 70Mt in 2030: with this perspective, the photo-electrochemical (PEC) approach could represent a good candidate for achieving this goal [2]. The possibility of directly converting sunlight into chemical energy (avoiding the intermediate step of converting sunlight into electricity) prevents energy loss, thus resulting in an overall increase in efficiency. Not only the classic photoelectrochemical water splitting should be taken into account for the production of green H2, but also the possibility of using wastewater that contains organic compounds (like biorefinery treatment water). In this contribution, we expose the advantages of using PEC-assisted water splitting and ethanol degradation reactions to produce green H2. The discussion mainly focuses on the anodic part of the cell, which begins with developing the electrode for the oxidation reaction. Specifically, metal oxide-based 2D [3] and 3D-type [4] electrodes were developed and processed in different cell configurations: nominally liquid-phase (LP) and gas-phase (GP) configurations. During the photodegradation of ethanol not only the valuable green H2 is produced (in the cathodic compartment) but also it is possible to obtain acetaldehyde, with different selectivity (that strongly depends on the cell configuration) which is a high-value product for the fine chemical industry.

Biography

Francesco Tavella got his PhD in Engineering and Chemistry of Materials and Constructions at the University of Messina in 2018. He is co-author of 19 publications in scientific journals and his main research interests include sustainable production of fuels and chemicals, design and development of photo-electrochemical devices and synthesis of nanostructured electrodes for fuel production and/or sensing applications.