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Editorial

Special Issue: New Trends in Photo (Electro)catalysis: From Wastewater Treatment to Energy Production

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This Special Issue aimed at focusing on photo- and photo-electrocatalytic processes specifically devoted to present both new catalytic materials and possible applications in environmental and energetic fields.

In fact, solar-driven photoelectrocatalytic (PEC) processes could be considered as one of the focal points to which the research should be addressed in the next future to achieve optimal results in environmental recovery and energy production. However, due to the low efficiency and selectivity of photocatalytic processes under solar energy, a major challenge exists to improve the performance of photocatalytic materials and increase the effectiveness of single and combined processes.

In this context, I would like to sincerely thank all the authors who accepted the challenge and collaborated with their excellent contributions to this Special Issue, which includes ten articles and five review papers.

Summarizing, the papers present both state-of-the-art and new trends on wastewater treatment and sustainable methods for organic degradation and energy production.

Among the different proposals TiO_2-based materials remain one of the protagonists in most of the papers, which used titania as single electrode material or in combination with either metal oxides or noble metal nanoparticles [1,2]. The effectiveness of the prepared electrodes, as well as the effect of the physical characteristics of the synthesized materials on the final PEC performances, are generally assessed during waste water treatment processes (WWTP) for the removal of organic pollutants, with special attention on persistent organic pollutants, drugs, or dyes which represent the most problematic classes of substances in traditional WWTP.

Analogous processes have been examined at different catalysts such as spinel $ZnFe_2O_4$ (ZFO) [3] ZnO/Ag [4], or Niobium-based metal oxides [5], which are generally proposed as photoanode materials for organic degradation in different range of wavelength of the irradiating light.

The synthesis of cathodic materials has also been investigated. Electrochemical dealloying has been proposed [6] where starting from Ni-Cu co-deposits, highly porous Ni electrodes were obtained, which demonstrated greater activity towards hydrogen evolution reactions, in comparison with commercial smooth Ni electrodes.

Cathodic materials were also the focus of some papers in which WWTP were coupled with the electrical energy production in microbial fuel cells [7,8]

The effectiveness of PEC processes has been assessed also in combined processes with sono-electrolysis for the degradation of drugs [9]: in that case boron-doped diamond electrodes were used, which are widely known in the electrocatalysis field.

Moreover, the development of photoactive and durable floating devices has been proposed for the treatment of water basins [10]. The major challenge in this field is the development of effective devices which allow an easier retrieval of the photocatalyst than in the case of powder catalysts. This allows for a more efficient light usage, since light, especially UV, attenuates rapidly in water.

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Five review papers completed the picture, by presenting a wide panoramic on the recent progress in the development of novel photocatalysts for H2 production by water splitting or for WWTP [11,12]. Graphitic carbon nitride materials [13] and metal sulphide composite nanomaterials [14] have been proposed as photocatalysts, and numerous strategies have been developed for their preparation. Finally, a brief summary of the current challenges and an outlook for the development of composite photocatalysts in the area of wastewater treatment were provided [15].

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