Photoelectrochemical response of nanoporous carbons/semiconductor films

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Semiconductor-based photocatalysis has become a topic at the forefront of technology in various disciplines, particularly in the fields of solar light conversion for environmental remediation, and in the production of energy (photochemical water splitting, photorreduction of CO_2 into fuels). However, a major drawback of most semiconductors is that much of sunlight is wasted due to their poor photonic efficiency (i.e., sunlight exploitation of TiO_2 is lower than ca. 4 %). In this regard, extensive work has been carried out to couple semiconductors with a variety of carbon materials of different forms and morphologies for enhancing the response of the semiconductor/carbon composites in the UV-visible light range. Overall, it is accepted that the role of a carbon material as additive to a semiconductor differs greatly depending on the structural features of the carbon material itself. Additionally, the target reaction is also important as it may be largely affected by the affinity of the carbon material used as additive or photocatalyst.

Recently our research group provided the proof of the concept of the photocatalytic activity of semiconductor-metal-free nanoporous carbons under UV-VIS irradiation, as well as the first experimental evidence on their ability to generate reactive radical species when exposed to light in aqueous environments. This study opened up new perspectives on the use of nanoporous carbons as in heterogeneous photocatalysis for the degradation of pollutants, and the topic has become a largely investigated one.

The aim of this study is to provide an overview on the possibilities of exploiting the interactions of nanoporous carbons and different sources of irradiation (UV, simulated solar light) in different fields of research, covering the progress in the photodegradation of pollutants using nanoporous carbons as photocatalysts (where the carbon has a dual role as photocatalyst and adsorbent for promoting the degradation of the pollutant and self-regenerating the exhausted carbon bed), as well as new perspectives on the use of nanoporous carbons as additives to semiconductors in hybrid photoanodes for the photoelectrochemical water splitting and the formulation of self-cleaning paints for indoor applications.

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References

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