An overview about micrometric semiconductor materials to be employed in photocatalytic applications

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It is well known that, among the semiconductor materials that might be employed to exploit photocatalytic application, TiO_2 has been widely studied starting from 1980, as it is not toxic and stable by its chemical nature: so far, it is also true that if it is prepared in the form of nanoparticles tends to aggregate in some environments, including biological ones, to form clusters of a bigger size [1]. The main question is if it is necessary to use nano-sized particles in an exclusive way. Kwon et al. stated that nanocatalysts having small particle size, high surface area, and a high density of surface coordination unsaturated sites offer improved catalytic performance over microscale catalysts but this does not imply the impossibility *a priori* to use larger particles in selected conditions [2]. In fact, it is possible to demonstrate that large-sized TiO_2 particles possess plenty of uses in photocatalysis, opening the door to the employ them, especially in formulations avoiding separation difficulties [3]. In the last 15 years it has been stated that micrometric TiO_2 (in particular, Kronos powders) can successfully substitute the reference P25 material in most of the photocatalytic applications, even though the limit of illumination by UV light still remain a drawback. In order to move to the employ of solar/led irradiation, it is well known that the promotion of TiO_2 by addition of extra species (such as C, N, transition (noble) metals) might be very helpful, but somehow it can be either tricky for the preparation or cost-effective [4]. Moreover, alternative materials are being explored. Among these, strontium titanate, $SrTiO_3$ (STO), has demonstrated optimum features to be applied as a photocatalyst for the removal of organic pollutants: both its typical perovskite-type phase and chemical and physical stability are advantages for strong catalytic activity. To boost its performance, in many studies, metals have been additionally introduced to dope its perovskite structure, by forming heterojunctions or incorporating defects into the lattice, in particular to improve its efficiency under visible light radiation [5].
In the present communication an overview about both kinds of materials (micrometric TiO_2 and STO) will be reported, with examples of applications, emphasis on characterisation and some future perspectives explored to further improve the photocatalytic results in both gas and liquid phases.

References

[1] C. Schulze *et al.*, Nanotoxicology 2 (2008) 51–61; DOI: 10.1080/17435390802018378
[2] S. Kwon *et al.*, Critical Reviews in Environment Science and Technology 38 (2008) 197–226; DOI: 10.1080/10643380701628933
[3] C. L. Bianchi *et al.*, Applied Catalysis B: Environmental 146 (2014) 123– 130; DOI: 10.1016/j.apcatb.2013.02.047
[4] (a) M. Stucchi *et al.*, Ultrasonics - Sonochemistry 51 (2019) 462–468; DOI: 10.1016/j.ultsonch.2018.07.011; (b) N. Haghshenas *et al.*, Catalysis Communications 181 (2023) 106728; DOI: 10.1016/j.catcom.2023.106728
[5] R. Djellabi et al., J. Hazard. Mater. 2022, 421, 126792; DOI: 10.1016/j.jhazmat.2021.126792