Design of nano-TiO_2-Surfactin hybrid systems suitable for the removal of water pollutants.

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Background, Motivation and Objective

The concurrent removal of organic (molecules, oils) and metal pollutants from contaminated sites (water or soil) is a big challenge that can take advantage by the simultaneous action of biosurfactant (amphiphilic molecules, deriving by microbial fermentation) and heterogeneous high surface area photocatalysts such as nano-TiO_2. The well-known light-activated capacity of nano-TiO_2 to oxidate/mineralize organic compounds [1], in fact, can be coupled with the capacity of very active surfactants such as the bio-surfactants (biological derived ones), to remove oils and organic pollutants from water through micellar sequestration and metal (loids) by the binding capacity of their polar ends [2]. On the basis of the above considerations, a series of new inorganic−organic hybrid materials based on TiO_2 and Sodium Surfactin (SS) biosurfactant were successfully prepared using different synthetic conditions. To understand the role of the hybrid components and the synergistic action that they can generate, the physicochemical properties of the produced composites were measured and functionalities tested for their use as: photocatalysts in the degradation processes of aqueous pollutants; antibacterial textile coatings to prevent the colonization and transmission of microbial pollutants; high surface area adsorbent matrices for the decontamination of water and soil from heavy metals.

Statement of Contribution/Methods

The following design options were adopted (Fig. 1). Sol-gel synthesis of TiO_2 nanoparticles nucleated over SS solution was performed, varying the TiO_2:SS weight ratio and the products compared with TiO_2 nanoparticles obtained by replacing bio-surfactant with a chemical surfactant (Triton X) at very low concentration (TiO_2:Triton 1:0,06)[3]. The last product was mixed with SS by ball-milling in a pH range where both surfaces TiO_2@TX and SS had opposite charges, to promote the electrostatic interaction and verify if potential synergetic effect arose by the nucleation of TiO_2 over SS or by the simple physical mixing between the two phases.

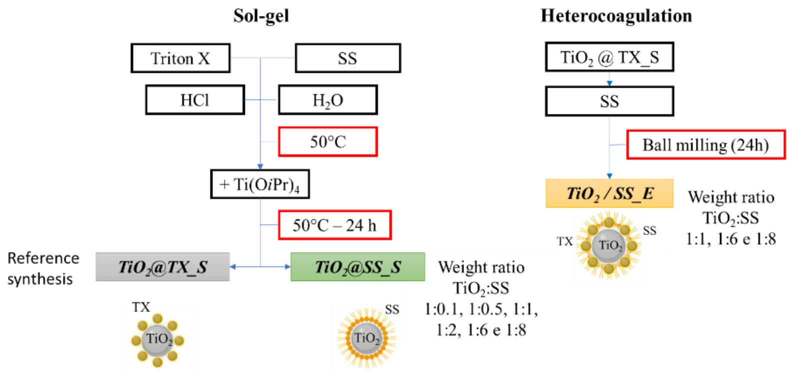

Fig. 1_ Design options adopted to develop the hybrid systems

Results/Discussion

From the comparison of different samples (varying the TiO_2/SS ratio and synthesis method), characterized and tested for different functionalities (at dispersed state and deposited on textile) and hypothesizing different applications (heterogeneous photocatalysts, UV-blocker in cosmetics, antimicrobial coatings, adsorbent matter for water/soil remediation) we can conclude that:

1. at low SS contents, the photocatalytic properties of TiO_2 are preserved and the hybrid systems can be used in advanced oxidation processes, taking advantage of the additional SS properties;
2. at high SS contents, TiO_2 loses its photo-activity due to the SS coating quenching effect, so the hybrid can be usefully exploited as UV-blocker in cosmetics, avoiding undesired oxidative effects;
3. in the combined adsorbent system, the TiO_2 can improve stability and density of the bio-surfactant, allowing easy transport and recovery from the medium, the SS can improve TiO_2 dispersibility, maximizing the availability of surface sites, for the concurrent removal of inorganic, organic, biological pollutants.

References

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