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Hybrid swellable silicas as adsorbent for the removal of organic dyes from water media

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Organic dyes are a class of compounds largely used for industrial applications, but they can have adverse effects for the environment and humans; for this reason, there is the needing to find convenient processes to remove these compounds from wastewaters. Due to its efficiency, low cost and versatility, adsorption on porous materials is considered a valuable solution for the decontamination of water from organic dyes[1]. Nevertheless, commercial adsorbents (i.e. carbons, clays) lack of affinity towards certain dyes or are characterised by low removal efficiency and/or are difficult to be regenerated and then reused. For these reasons, the research work devoted to the study of new and more performant solids deserved increasing interest[2].

Swellable Organically Modified Silicas (SOMS) are a class of hybrid silicas with peculiar adsorption properties for PFAS[3] and VOCs[4] species. SOMS are hybrid materials formed by polycondensation of a bis-silane that contains an aromatic ring linked to an ethyl group as binding unit between Si atoms. These materials possess the peculiar ability to swell when in contact with organic solvents thus resulting in an improvement of SOMS adsorption capacity[4].

In this work, SOMS silicas have been prepared by an optimised sol-gel approach and characterized from the physico-chemical point of view through a multi-technique approach. SOMS possess an irregular shape and distribution of particle dimensions, with a surface area of ca. 420 m^2/g and an irregular distribution of pores dimensions. SOMS have been functionalised using a quaternary amino group, thus conferring a positive surface charge to the material (QA-SOMS).

The adsorption performances have been tested against different dye molecules (i.e. Rhodamine B, Methyl Orange, Crystal Violet). In particular, the kinetics, and effect of pH have been studied. The materials can be regenerated with a simple sonication in ethanol and reused for 6 adsorption cycles, showing no losses in adsorption performances, which remain very rapid and high in terms of quantity removed for every cycle. Finally, mixtures of dyes have been also tested for the first time.

References:

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