Hybrid and Swellable materials for the adsorption of organic dye molecules

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Organic dye molecules are used ubiquitously in industries, and are among the contaminants responsible for soil, air, and water pollution. The removal of organic dyes from wastewater can be made by physical, biological, and chemical methods, but the adsorption on solid sorbents is considered an efficient process and is becoming one of the standard treatments industrially used [1].

The widely used commercial adsorbents (for instance, carbons and silica-based materials) lack of affinity towards certain dyes or have low removal efficiency or are not easily regenerable and this is thus associated to the needing to study new materials with improved adsorption performance [2].

Swellable Organically Modified Silicas (SOMS) can be good candidates for the adsorption of dyes from water, considering that these materials have proven to be excellent adsorbents for perfluoroalkyl substances (PFAS) and other species, such as organic chlorinated solvents (tetrachloroethylene) [3,4].

SOMS are hybrid materials prepared by sol-gel process using bis(trimethoxysilylethyl)benzene, a bis-silane precursor containing an aromatic ring linked to two ethyl group as binding unit between the two Si atoms. SOMS can be also functionalized with a positive charge group, by adding a quaternary amine silane in the synthesis (QA-SOMS) [4].

In this work, SOMS and QA-SOMS silicas have been prepared and characterized by a multi-technique approach to have information on their physico-chemical properties. These amorphous materials possess an irregular shape and distribution of particle dimensions with also irregular mesoporosity.

The adsorption performances have been tested in the presence of different dye molecules (e.g. Rhodamine B, Methyl Orange, Crystal Violet) and compared with those of classical organically modified mesoporous silicas such as SBA-16 (Figure 1).

The adsorption kinetics, effect of pH and adsorption isotherm have been studied. SOMS and QA-SOMS appeared to be easily regenerable through a simple sonication process in ethanol and reused for several adsorption cycles, showing no losses in adsorption performances.

Finally, the removal of mixtures of cationic dyes have been tested.

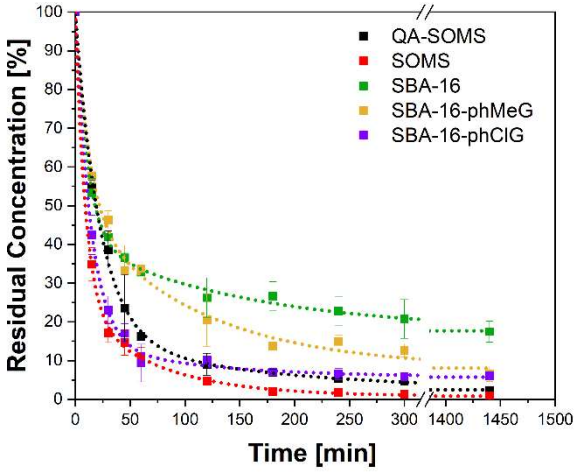

Figure 1: *Adsorption kinetics of a 100 ppm solution of crystal violet by SOMS, QA-SOMS and mesoporous silica SBA-16 both organo-functionalized (SBA-16-phClG and SBA-16-phMeG) and not (SBA-16).*

References

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