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Chelating magnetic mesoporous silica materials for metallic micropollutants removal

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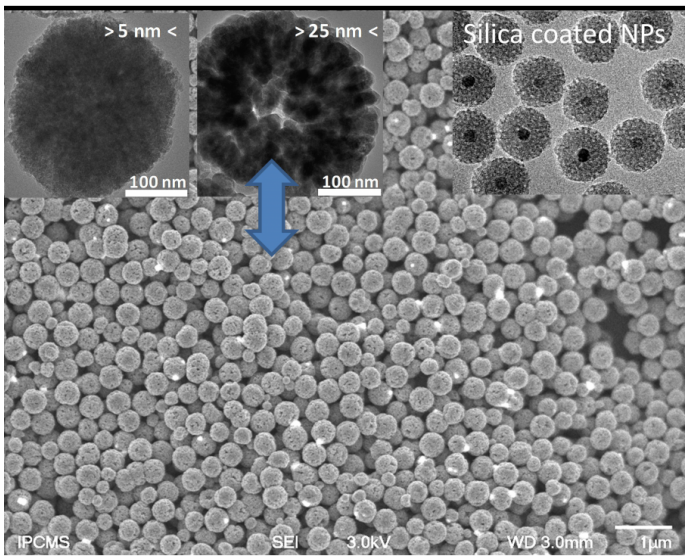
PURPOSE OF THE ABSTRACT

The objectives of this work are to develop an innovative process using fully efficient and recyclable strongly chelating magnetic mesoporous silica materials that will find applications for the removal of micropollutants from industrial discharges, sewage water or sludges. The remediation/decontamination of toxic metals is an important issue which concerns various sectors of the society: environment, agriculture, industry... However, the materials and methods currently used to address this issue have different limitations. For instance, the decontamination of industrial effluents requires the use of ion exchange membranes which are not suitable for highly charged solutions or suspensions such as contaminated sludges. Different systems implying magnetic particles have already been shown efficient for purification by magnetic separation at industrial scale but some disadvantages could be identified. On the other hand, regulations impose more and more severe release standards of contaminants into natural or biological environment. Such issues trigger importantly the development of decontamination methods in terms of efficiency, costs, and risks for health. It is also important to be able to target metallic pollutants in order to respond to industrial and regulation constraints.

Thus, there is an important need to design new and easily implemented processes making use of functional materials ensuring an efficient and selective removal/recycling of micropollutants in various media. Sorption is considered as one of the most promising technologies due to its flexibility in design and operation, potential for regeneration of sorbents, sludge free operation and high retention efficacy when applied with the proper sorbent. To ensure high captation and then removal, the use of selective chelating agent appears very promising but they have to be immobilized on supports allowing high loading of chelating agents. For the decontamination of toxic metals, the best chelating agents should contain amine and/or thiol groups (aminoacids, gluthatione, ?). Among current support allowing high loading of molecules, mesoporous silica are very suitable and the presence of the magnetic core will facilitate the separation.

The choice of the chelating agent, its hability to complex selectively the target metal, the influence of the magnetic core shell particles on the binding of the ligand to the metal, the decomplexation conditions are crucial steps to ensure the robustness of the process and were carefully investigated by testing different chelating agents for the capation of iron and of other ?big? metals. The complex for Fe captation is deferoxamin B because his iron complexity constant is very high (?=1030) and high and fast captations were demonstrated in optimized conditions as well as the easy recycling of such chelating magnetic materials. The captation of big metals was more complew and different ligands were tested and compared. Thus, together with the carefull and precise thermodynamic and kinetic evaluation of the efficiency of such chelating adsorbent materials, these new chelating materials are developed for different ranges of pollutant concentrations and in particular for low concentration level (trace species).

FIGURES



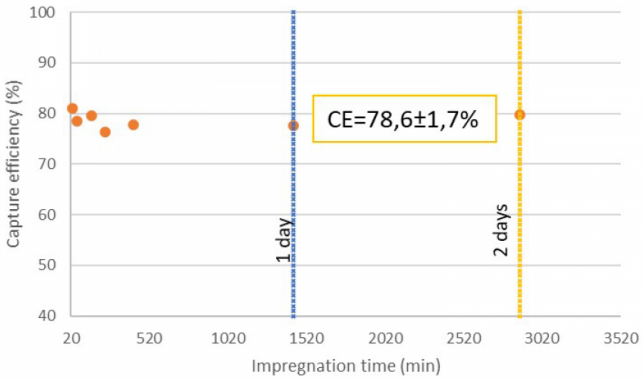


FIGURE 1

Silica coating of the iron oxide particles

SEM and TEM images of Iron oxide particles with and without silica coating

FIGURE 2

Iron capture efficiency

Capture efficiency =100x (n fer en solution (mol))/(n DefoB greffés (mol))

Stoichiometry Fe:DefoB (1:1). Study on two days-Reaction kinetics.

KEYWORDS

Iron Oxide | Iron capture | Silica coating

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