Intitulé du Sujet de Thèse : Design of porous materials for drug delivery systems

Laboratoire : MADIREL

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Project Description

Porous materials are highly adaptable, allowing new materials to be optimized or designed in terms of functionality. They are characterized by a three-dimensional structure, cavities or pores and an internal surface. These three elements open important prospects in terms of properties and, therefore, potential applications. The internal surface is responsible for the many catalytic and adsorption properties of porous solids. These properties are even more interesting when the internal surface is large and/or modified. The pores or cavities can be used in several ways. The available pore volume allows molecules to be trapped. This ability to trap compounds is used in several applications such as storage and controlled release. These pores can also be used as chemical nanoreactors to prepare composite materials or for the confinement of unstable compound. The chemical nature of the porous framework can also be tuned according to the targeted property.

The main objective of PhD work is to design porous materials by adjusting the three parameters described above, with a view to their application in controlled drug delivery. Indeed, the growing interest for finding more efficient drug administration has induced huge research efforts devoted to the design of new functional materials as controlled drug delivery systems (DDS) to maximize therapeutic efficacy and minimize side effects. Two main strategies will be implemented to enhance therapeutic efficacy:

- the development of stimulus-responsive mesoporous silicas in which drug release can be triggered by exogenous or endogenous stimuli, such as pH or light [1-2]. In this context, we aim to study the simultaneous adsorption of multiple pharmaceutical active ingredients (PACs) belonging to different therapeutic classes (anti-inflammatory, anticancer, antiparasitic, and antiseptic drugs). Indeed, the research team have demonstrated cooperative effects that allow for a significant increase in the amount of PACs incorporated and, thus, delivered [3].
- the increase the bioavailability of PACs by increasing their solubility. This will be achieved by a double functionalization of this material. The first consists in incorporating the PACs into the pores of the material to stabilize them in their amorphous form, thereby increasing their bioavailability [4]. The second consists in functionalizing the surface of the material with a biocompatible polymer to maintain the metastable state obtained previously.

This PhD topic will comprise the following tasks:

1- Synthesis and characterization of porous materials: sol-gel chemistry, textural properties (nitrogen adsorption manometry, TEM, mercury porosimetry), morphology (SEM), crystal structure (X-Ray Diffraction)

2- Surface Functionalization of porous materials: post-synthetic synthesis, functionalization rate by thermogravimetric analysis (TGA), FTIR, polymer solubilization conditions,

3- PACs loading and release properties: loading amount (TGA), amorphous character of PACs (DSC), kinetic and thermodynamic study by HPLC/UV-visible spectroscopy and calorimetry,

4- Antioxidant efficacy and biocompatibility (cell culture) of materials after drug loading and functionalization (in collaboration with ICR, Faculty of Pharmacy, Marseille).

References

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