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The Release Properties of the Mesoporous Materials SBA-15 and PHTS for their Use in the Controlled Release of Ibuprofen and Vancomycin

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1. Introduction

Mesoporous materials are emerging as new drug delivery systems. Drug-loaded particles appear suitable for controlled release and drug targeting. These particles may have a potential as drug carriers because they could be able to enhance the bioavailibilty of poorly absorbed drugs, entailing a lowering of the therapeutic dose. These particles could also be efficient for entrapping slightly water-soluble drugs. MCM-41 is a typical mesoporous templated silica and it presents nanosized pores that allow the inclusion of drugs. Therefore, this material has been largely studied as a potential drug delivery system and shows promising results [1-3]. A serious disadvantage of MCM-41 is its low stability.

In this work, two promising mesoporous materials (SBA-15 and PHTS) were tested on their release properties of ibuprofen and vancomycin. Ibuprofen (2-(4-isobutylphenyl)propionic acid) was selected as one of the model molecules since it is a well documented and much used non-steroidal anti-inflammatory drug. Vancomycin is an antibiotic drug as well as a very big biomolecule. Since these two molecules have largely different molecular sizes, a difference in diffusion rate can be expected.

SBA-15 and PHTS (Plugged Hexagonal Templated Silica) are both SBA (Santa Barbara Amorphous) –type materials. SBA-15 consists of a 2-D hexagonally ordered array of long pore channels with diameters that can vary within the range of 4.6 – 30 nm [4]. This material has a high thermal and hydrothermal stability compared to M41S-materials [4] and has both meso- and micropores [5]. PHTS is a plugged variant of SBA-15. It contains extra silica nanoparticles (“plugs”) inside the mesoporous channels, which makes PHTS more stable than the pure SBA-15 [6]. Moreover, these plugs will probably have an effect on the diffusion of molecules.

Materials with combined micro- and mesoporosity can offer advantages such as the capability to encapsulate drugs in the micropores and an improved diffusion rate in the release of these compounds.

2. Experimental Section

The Zero Length Column (ZLC) technique [7-9], was used to measure desorption of the chosen pharmaceutical compounds. The experimental setup consists of two syringe pumps which ensure a constant flow through the column. An inox column

with an internal diameter of 1.6 mm, a length of 3 mm and minimal dead volumes was developed. In this column around 6 mg of material could be packed.

Ibuprofen was loaded into the mesoporous material in two different ways. One way was to bring the material together with ibuprofen and hexane in a vial and stirring for 24 hours. Afterwards the material was packed into the ZLC-column. Then the column was purged with a flow of pure hexane and desorption of ibuprofen was followed with an UV-detector. Ibuprofen shows a strong absorbance at 254 nm.
In the other case the material was first packed into the ZLC-column. Then the sorbent was equilibrated with a flow of hexane with 1% ibuprofen. Once equilibrium was reached, the flow was switched to pure hexane and again desorption was followed with an UV-detector.
The same was done with ethanol and water as solvent to check if the interactions between the compound and the mineral surface of the mesoporous material did depend on solvent properties. Vancomycin was not soluble in hexane and ethanol. Therefore this experiment was only done with water as solvent.

3. Conclusion

SBA-15 and PHTS exhibit exciting structural features and are therefore promising for their use as drug delivery system. The effect of the plugs of PHTS, the influence of different solvents and of the molecular size of the pharmaceutical compounds and the effect of the preloading procedure on these release properties was discussed.

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