Functionalization of mesoporous silica material (SBA-15-type) with polyether chains as a strategy for controlling antibiotic delivery

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Abstract

Adsorption studies of tetracycline on the mesoporous silica SBA-15 functionalized with polyether chains (PE) in various proportions (ranging from 0.1 to 0.8 mol%) were performed. Thermogravimetric Analysis (TGA) showed influence of initial concentration of tetracycline on the loading. N_2 adsorption/desorption showed that pore volume (Vp) and specific surface area (SSA) decrease after drug encapsulation.

Key words: SBA-15, Tetracycline, Drug Delivery System

Introduction

Mesoporous silica materials present high potential as drug carriers due to high pore volume and superficial area,¹ which can allow the adsorption of large amounts of drugs in the structures. Additionally, the surface functionalization of silica² permits the inclusion of moieties or ligands that can improve pharmacokinetic properties of solids and mediate selective interactions with cells and microorganisms³.

In this sense, our purpose is to produce a hybrid organic-inorganic material based on the silica SBA-15 functionalized with polyether chains⁴ aiming at the delivery of antibiotics.

Results and Discussion

The synthesis method (Image 1) is based on the polycondensation of TEOS and bis-silylated pluronic P123. One pure SBA-15 sample and 4 samples with (bis-silylated P123)/(bis-silylated P123+P123) ratio ranging from 0.1 to 0.8 mol % were prepared.

Image 1. Scheme of the synthesis of silica SBA-15-based materials.

N_2 Adsorption/Desorption (Chart 1) points out the influence of PE chains proportion in the surface area - SSA and pore volume - Vp.

TGA analyses (Image 2) show that the amount of adsorbed drug increase when concentration is 10 mg/mL rather than 50 mg/mL. Following the material and the initial concentration of

tetracycline, drug loading is in the range of 20-35 wt%.

Image 2. TGA after tetracycline encapsulation (10 and 50 mg/mL) at ambient conditions for 24h.

Chart 1. N_2 Adsorption/Desorption. Before (Black) and after (red) drug encapsulation (50 mg/mL)

Tetracycline 50mg/mL	BET Surface Area SSA ($m^2 g^{-1}$)	Pore Volume ($cm^3 g^{-1}$)	Average Pore Width (nm)
SBA-15	750 / 370	1.3 / 0.7	7/7
0.1mol%PE	650 / 240	1.2 / 0.4	7/7
0.2 mol%PE	570 / 250	1.1 / 0.5	8/7
0.4 mol%PE	430 / 230	0.9 / 0.5	9/8
0.8 mol%PE	280 / 180	0.7 / 0.4	11/9

Conclusions

An original synthesis method is proposed. The produced materials enable high SSA and high drug loading (20-35 wt%).

Acknowledgement

Thanks to the support of CNPEM/LNLS, CNPq, FAPESP and CAPES funding.

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