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# Synthesis, Characterization and Application of Mesoporous Materials in the Controlled Release of IBUPROFEN

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**Abstract**

Drug delivery systems consist of an active ingredient and a carrier system that can direct the release of the drug to the appropriate site and in the appropriate amount. The characteristics that these vehicles must meet are low toxicity, optimal properties for drug transport and release, and long half-life. Three mesoporous materials are reported in this work, the first one containing lattice aluminum; named Al-Si/SBA-3; the second one containing magnesium; named Mg-SBA-3, and the third one named LP-SBA-15. These materials were characterized by X-ray diffraction, resulting in hexagonal porous nanostructures, with lattice parameters of 3.63 nm for Al-Si/SBA-3 (without significant changes in the periodicity of the lattice). LP-SBA-15 is a novel large porous nanomaterial. It is encouraging the results of the application of these materials as host-transporters in the study of the modified release of Ibuprofen. LP-SBA-15 appears to be the most promising delivery system for IBU and its controlled release.

**Introduction**

Drug delivery systems consist of an active ingredient and a carrier system that can direct the release of the drug to the appropriate site and in the appropriate amount. The

characteristics that these vehicles must meet are low toxicity, optimal properties for drug transport and release, and long half-life [1]. Nanotechnology allows drug release to be minimally invasive since it enables the fabrication of devices at the nanometer scale, a size that allows these devices to pass through pores and cell membranes. Another great advantage that nanotechnology has brought to drug delivery is that the effectiveness of the drug is increased by precisely controlling the required dose and the size, morphology, and surface properties of the compound [2].

**Experimental**

Si-SBA-3 samples are prepared by employing cetyltrimethylammonium bromide (CTABr, Aldrich) and tetraethyl orthosilicate (TEOS, Aldrich, 98%), as surfactant and Si source, respectively. An aqueous HCl solution (37%) is used to adjust the pH value of the reaction system. 2-4 g of CTABr and 40-60 mL of HCl (37%) are dissolved in 100 mL of deionized water. TEOS (10-15 mL) is added dropwise to the acidic CTABr solution with vigorous stirring without exceeding 30 ºC. After 2 to 4 h, the resulting white precipitate (stock SBA-3) is allowed to age at room temperature for an additional 24 h. It is filtered and dried at 100 °C. It is filtered and dried at 100 ºC for more than 24 h. The synthesized solid, Si-SBA-3, the surfactant is extracted by refluxing it with ethanol; it is filtered and washed with distilled water. After drying, it was calcined at 550 °C for 12 h (to complete the surfactant removal), before characterization. The heating rate was from 100 ºC to 550 ºC at 2 ºC/min.

Post-synthesis alumination of these materials were synthesized by using sodium aluminate, in the case of Al-Si/SBA-3 and by incipient moisture impregnation in the case of Mg-SBA-3. LP-SBA-15 [3], was synthesized with pore sizes greater than that of a traditional SBA-15, we followed a method that uses an expanding agent of micelles. Specifically, 2.4 g of the template ingredient (Pluronic 123 copolymer, Aldrich) and 0.027 g of NH4F dissolved in 85 mL HCl (1.3 M) at ambient temperature were placed in a water bath at 17ºC for 1h. Later, 5.5 mL of tetraethylortosilicate (TEOS, Aldrich) and 1.2 mL of 1,3,5-triisopropyl benzene (TIPB, Aldrich) were incorporated and maintained with mechanical agitation at this temperature for 24h. The remaining white suspensions were then aged at 100°C (LP) under static and autogenic pressure for 24 h. The solid products were collected by filtration. To eliminate the templating agent, the solid obtained was

heated under a flow of N2 at 20 mL / min at 470 °C and then heated again at 550 °C under static air for 6 h. Using XRD and FTIR the structural properties of these materials will be characterized. In this work, results of the development of Mg-SBA-3 (hexagonal P6m) with a pore diameter of about. The resultant mesoporous material large pore SBA-15 was named LP-SBA-15 displays a high reflection peak (1 0 0) and two minor peaks (second- and third-order peaks), corresponding to the diffraction planes (1 1 0) and (2 0 0)). These peaks can be indexed with a hexagonal crystallographic structure of the P6mm group [4].

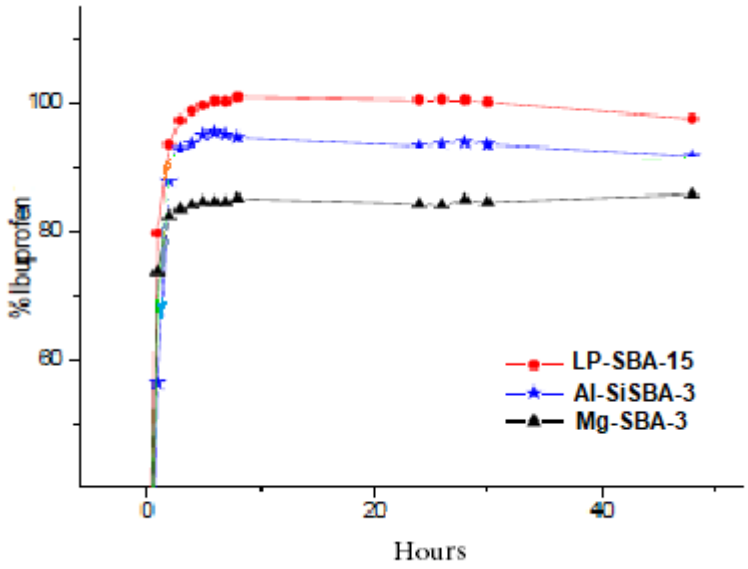
**Controlled Release Of Ibuprofen:**

The adsorption of ibuprofen is performed by impregnation of an Ibuprofen solution at a constant temperature, and then the samples are oven-dried at 37°C for 24 hours. The samples are characterized to check that the material has not been altered. Ibuprofen is released by introducing the samples into the medium, in this case, "Simulating Body Fluid", SBF (a mixture of sodium, potassium, calcium and magnesium chlorides, sodium bicarbonate, di-potassium phosphate, hydrochloric acid, and sodium sulfate). The assay is dynamic, with constant agitation of 60 rpm and in a thermostatic bath at 37ºC to reproduce the release conditions in the human body. Next, aliquots were withdrawn with a syringe at programmed times, adding SBF to maintain the initial volume. The withdrawn solution was filtered with Millipore filters. The concentration of ibuprofen was determined using an HPLC [5]. This work shows a comparative result of the application of Al-Si/SBA-3, Mg-SBA-3, and LP-SBA-15 type materials in the controlled release of Ibuprofen "in vitro".

**Resulsts**

In Figure 1 it can be seen that the drug molecule also influences the release rate, depending on the types of bonds it forms with the material, and in this case its diffusion through the channels and their pore sizes. Therefore, several factors influence the release of the initial volume. The withdrawn solution was filtered with Millipore filters. The concentration of ibuprofen was determined using an HPLC. In this work, we show the results of the application of Al-Si/SBA-3, Mg-SBA-3 and LP-SBA-15 type materials in the controlled release of Ibuprofen "in vitro". The pore diameter of the material and the bonds established with the walls of the nanostructures and their anchoring sites are in any case the basic parameters of reference in the controlled release of IBU.

Of the three siliceous materials used, the LP-SBA-15 with larger pore size indicates a higher proportion of drug release (100%) than the SBA-3 with smaller pore size, and there may be diffusional impediments in the latter. Perhaps most importantly, LP-SBA-16 is able to receive more than 40% of IBU with respect to SBA-3, and still deliver it completely.




**Conclusions**

Three mesoporous materials are reported in this work, the first one containing aluminum in-network; named Al-Si/SBA-3; the second one containing magnesium; named Mg-SBA-3, and the third one named LP-SBA¬15 (large pore). These materials were characterized by X-ray diffraction, resulting in hexagonal porous nanostructures, with lattice parameters of 3.63 nm for Al-Si/SBA-3 and LP-SBA-15 with hexagonal crystallographic structure of the P6mm group. Promising results are shown here of the application of these materials as transporter-hosts in the study of the improved release of Ibuprofen. LP-SBA-15 uptakes more than 40% of IBU with respect to SBA-3, and delivers it completely after 8-10 hours. In all three materials, there is a fast release in the first hours and then a constant release of about 80, 90 and 100% for Mg-SBA-3, Al-Si/SBA-3 and LP-SBA-15 respectively.

## References

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