Protein encapsulation in functionalized and structured silica gel for bone reconstruction application

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**ABSTRACT:**

The goal of this work is to study the influence of the structured mesoporous silica (SMS), used as scaffolds for tissue engineering [1], on the encapsulation and on the release of a model bone morphogenetic proteins (BMP), i.e. Soybean Trypsin Inhibitor (STI).

First, SBA-15 silica samples were synthesized using tetraethyl orthosilicate (TEOS) as silica precursor in the presence of P123 as the surfactant in an acidic medium. In addition, a swelling agent was added to increase the pore size. Indeed, the common pore size for those mesostructured materials lies between 6 nm and 8 nm, while the STI has an average radius of 4 nm. The reactant addition sequence was also investigated. It was observed that when the swelling agent was added with the TEOS, a SMS was produced. On the contrary, if the swelling agent was added during the surfactant dissolution step, it resulted in an unstructured -but still mesoporous- silica.

Because of the high affinity of STI for hydrophobic surfaces [2], SMS were also produced using silica precursors containing phenyl groups (1,4-bis(triethoxysilyl)benzene, BTEB [3]). The BTEB samples exhibited two 2D-hexagonal structures with different wall thicknesses.

For samples synthesized with TEOS, the unstructured sample showed a higher protein loading and a higher protein release, which could be explained by a difference in the pore interconnectivity within the sample. In fact, a fast release of STI was observed during the first 24 h. Afterwards, the STI release slowed down and seemed to achieve a plateau. On the opposite, the SMS showed a steady release over time. Finally, the sample synthesized with BTEB did not show a significant release over the same period of time. This led us to the conclusion that the hydrophobicity of the silica surface plays a major role on the protein encapsulation and its release rate.



**Figure 1 : Release kinetics profile of STI from the TEOS and BTEB gels: (a) Release kinetics profile (b) Zoom on the possible burst (0 to 24 h) (c) Profile of the STI released after the first day (STI release up to 24 h is subtracted):** ◆ **TEOS-1,** ▲ **TEOS-4,** ◼ **BTEB.**

**References**

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