Synthesis and characterization of large-pore mesoporous silica structures

Debora Carrozza^a, Gianluca Malavasi^a, and Erika Ferrari^a

^a Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, via G. Campi 103, 41125, Modena, Italy, University of Bari, 70126, Italy

Cancer is a leading cause of death worldwide, with 10 million deaths every year. The use of nanosized carriers seems appealing owing to their capacity to encapsulate drugs within their structure [1].

The synthesis of silica-based materials with porous structures, suitable for the confinement of theranostic substances and their delivery, has attracted a lot of interest in the last years. Mesoporous silica nanoparticles have been widely applied as carriers for cancer treatment, thanks to the possible loading, inside the structure, of interesting anticancer molecules [1].

Silica structures are interesting due to their biocompatibility and biosafety. Also bioactivity [2] can be achieved if Ca²⁺ is included in the structure.

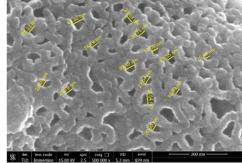
Mesoporous silica with different porous structures can be synthesized using different templates (porous-genic agents) and starting by TEOS (tetraethyl orthosilicate) as a precursor of silica structure.

With respect to the classical way of synthesis [3], in which are obtained structures with

mesopores in the range of 2-5 nm, a new way was followed.

In this study, we have concentrated on the synthesis of large pores meso-structures, with the purpose of loading inside pores bigger molecules (compared to classic ones) interesting from a biological point of view (i.e. P53 plasmid).

The synthesis were conducted in a large excess of the template, at high temperature and high Figure 1 – Large mesopores silica microparticles (LPMS) pressure [4]. This synthesis pathway allows



to obtain structures with mesopores in the range of 20-40 nm (figure 1).

^[1] M. Gisbert-Garzarán and M. Vallet-Regí, «Redox-Responsive Mesoporous Silica Nanoparticles for Cancer Treatment: Recent Updates», Nanomaterials, vol. 11, n. 9, pag. 2222, ago. 2021, doi: 10.3390/nano11092222.

^[2] M. Manzano and M. Vallet-Regí - 2020 - Mesoporous Silica Nanoparticles for Drug Delivery.pdf».

^[3] V. Nicolini et al., «Mesoporous bioactive glasses doped with cerium: Investigation over enzymaticlike mimetic activities and bioactivity», Ceram. Int., vol. 45, n. 16, pagg. 20910–20920, nov. 2019, doi: 10.1016/j.ceramint.2019.07.080.

[4] X. Zhang, D. Zeng, N. Li, X. Jiang, C. Liu, e Y. Li, «Large-pore mesoporous Ca–Si-based bioceramics with high in vitro bioactivity and protein adsorption capability for bone tissue regeneration», *J. Mater. Chem. B*, vol. 4, n. 22, pagg. 3916–3924, 2016, doi: 10.1039/C6TB00454G.