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Challenges on Protein Bioencapsulation in Transparent Nanoporous Sol-Gel Glasses and their Applications

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Abstract:
Transparent organic-inorganic nanoporous silica glasses obtained via the sol-gel method constitute the ideal support for protein bioencapsulation and the study of the different factors influencing the protein folding process in a crowded environment. Due to the facile silica surface modifications with the choice of Si-substituted organic groups, organically modified "wet-aged" based silica glasses can be used as host materials to mimic the crowded environment of the proteins and cells that can be found in the cytoplasm for instance. The transparent media allows spectroscopic studies such as the use of circular dischroism spectroscopy. We report the influence of different parameters (macromolecular crowding, porosity, hydrophobicity, surface hydration) on the protein conformation based on the design and the characterization of nanoporous silica-based materials bearing different functional groups favoring the protein folding (Figure 1). The enhancement of the protein folding owing the physical properties and microstructure of the host matrix induced by the nature of the functional groups and the siloxane network play a major role on the protein biological activity and therefore to the development efficient bionanodevices such as biocatalysts, sensors, drug delivery systems or implanted devices. In addition, we will introduce new challenges of using this type of host matrices in microbiology. This study will also permit us to discuss a new surfactant-free micropatterming process on the porous glass surface that we have enlightened with potential optical applications.

Keywords: protein folding, nanoporous sol-gel glasses, silica-based biomaterials, circular dichroism spectroscopy, surface hydration, crowding effects, micropatterning, biomedical applications.

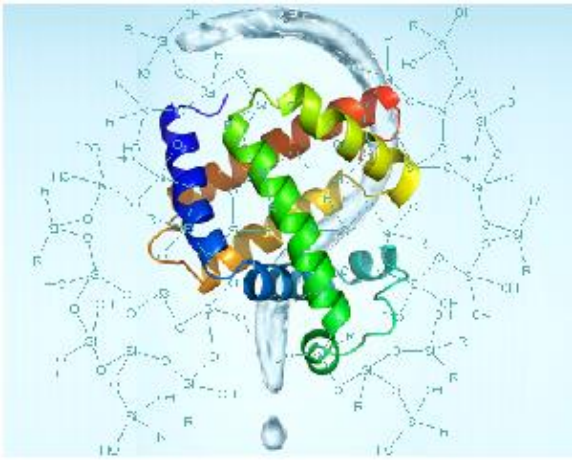

Figure 1: Figure illustrating the fundamental question that we are tempting to solve experimentally: what is the importance of silica surface modification nanoporous silica-based sol-gel glasses prepared from functionalized organosilane precursors on the parameters affecting the conformation, biological activity and functionality of encapsulated biomolecules.

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