

Microbial cells and silicate-organic sol-gels: self-organised biomatrix architecture formation

O.N. Ponamoreva¹, O.A. Kamanina¹, A.V. Machulin², N.E. Suzina², V.A. Alferov², E.P. Ivanova³

¹ Faculty of Chemistry, Tula State University, 92 Lenin av. Tula 300012 Russia - olga@tsu.tula.ru

² Laboratory of cytology of microorganisms, G. K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Sciences, 5 Nauki av., Pushchino Moscow reg 142290 Russia

³ Faculty of Life and Social Sciences, Swinburne University of Technology, PO Box 218, Hawthorn, Victoria, 3122 Australia

Abstract

The immobilization of enzymes and cells into silicate-organic sol-gel matrix has received significant amount of attention as a promising technology for development of biosensitive and biocatalytic materials^{1,2}. The latter allow high rate of diffusion, are very stable, have constant volume, and provide effective protection of immobilized material from mechanical, thermal and biological effects³. In this work we have investigated the dynamic transformation of the silicate-organic sol-gel matrix constructed from tetraethoxysilane (TEOS), hydrophobic additive – methyltriethoxysilane (MTES) and a porogen – polyethylene glycol (PEG) as the result of acetic acid bacteria *Gluconobacter oxydans* subsp. *industrius* BKM B-1280 and methylotrophic yeast *Pichia angusta* BKM Y-2559 encapsulation. While the three dimensional structure of intact sol-gel was composed of linked spheres of approximately 2 μm diameter, under specifically optimized experimental conditions, microbial cells were able to build a species-specific architecture of the sol-gel biomatrix. The yeast *P. angusta* become the nucleation centers and initiated a dynamic assembly of silicate-organic capsules of less than 1 μm around their cells with complete cell coverage in 5 hours (Fig. 1, 2). Bacterial cells of *G. oxydans* formed multicellular communities which were associated with the surface of hollow silicone spheres of size 20-50 μm (Fig. 1, 2). Remarkably the process of such self-assembly was very fast resulting in the giant spheres formed in 15 minutes. The biological activity of the encapsulated microorganisms as a functional biosensor receptor was also evaluated.

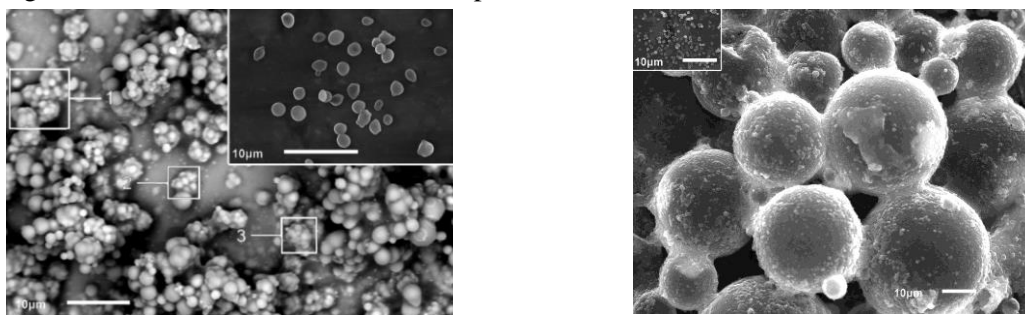


Fig. 1 Microbial cells encapsulated in sol-gel biomatrix. Scanning electron micrographs (SEM) showing methylotrophic yeast *Pichia angusta* BKM Y-2559 cells (a, left). The capsules around the cells are highlighted in the frames (1, 2, 3); *Gluconobacter oxydans* subsp. *industrius* BKM B-1280 cells immobilized on the surface of sol-gel spheres (right). Insets: The SEM images of intact microbial cells.

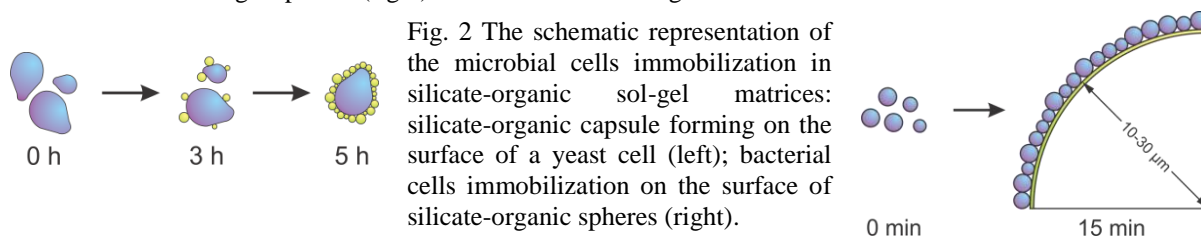


Fig. 2 The schematic representation of the microbial cells immobilization in silicate-organic sol-gel matrices: silicate-organic capsule forming on the surface of a yeast cell (left); bacterial cells immobilization on the surface of silicate-organic spheres (right).

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