BIOCOMPOSITE CAPSULES WITH SOL-GEL PROCESS

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Abstract

Bioencapsulation in silica gels has become a very field of research ,leading to the design of biosensors and bioreactors.If pure silica gels appear suitable to maintain the biological activity of entrapped enzymes ,there are many cases where hybrid materials are necessary to reach the long-term preservation of biomolecular or cellular species and/or to provide new functionalities. Among the wide diversity of applications of sol-gel hybrid materials,bioencapsulation approaches may be some of the most fascinating.

When trying to compare sol-gel technology with (bio)-organic polymer processes, the advantages of the former arise both from the intrinsic properties of inorganic materials (mechanical properties,physical and chemical stability towards organic solvents, ph, light and microbial degradation) and the flexibility of the sol-gel process (tailored porosity, chemical modification using organically-modified alkoxides).

We describe the synthesis of two novel composite systems through the controlled association of polysaccharides (agarose and carboxymethylcellulose CMC) with silicates.

The first system consists of preformed agarose capsules coated with silica. However,in both cases, the deposition of the silica layer was favoured by electrostatic inter-actions between the negatively-charged silicates and the positively-charged surface of the capsule.

The second system consists of hybrid gels obtained from CMC/silicate mixtures.The substitution of alkoxides by silicates is challenging as the reactivity of aqueous precursors towards bio-macromolecules may strongly differ from that of organosilanes,leading in many instances to the precipitation of silica/biopolymer aggregates rather than to bulk material formation.We show that silicates can interact with these two polysaccharides and form hybrid silica/biopolymer materials.

Infra-red spectroscopy and thermogravimetric analyses suggest that the silica-polymer interface is controlled by hydrogen bond formation.Scanning electron microscopy suggests limited modification of the agarose surface and of carboxymethylcellulose network organisation.

The synthesis and characterization of these bio-hybrid materials are described, emphasizing the importance of the polymer influence on the reactivity of silica precursors.
The benefits of biopolymer incorporation in silica gels are illustrated in the context of biotechnological devices.

A parallel is drawn between biohybrids and biominerals, opening new perspectives for the design of multi-component biologically-active materials.

Keywords : Biopolymer , Sol-Gel , Biotechnology.