Annals of Materials Science & Engineering

Open Access

Austin Publishing Group

Short Communication

The Immobilized Enzymes in the Composite Materials World

Monica Mesa*
Materials Science Group, Institute of Chemistry, University of Antioquia, Colombia

***Corresponding author:** Monica Mesa, Materials Science Group, Institute of Chemistry, University of Antioquia, Calle 70 No. 52-21, Medellín, Colombia

Received: April 16, 2015; **Accepted:** April 27, 2015; **Published:** April 29, 2015

The infinite world of composite materials is every time more and more amazing. This permeates different fields of knowledge such as materials science, engineering, medicine, between others. These materials are studied from practical and theoretical points of view, including basic knowledge and their applications. They were recognized in the microscopic scale but nowadays, the nanocomposite materials gain more attention, providing new opportunities and higher performance applications.

When the enzymes are immobilized in inorganic materials results a good example of this new generation of composite materials. Some years ago, think in the use of enzymes at industrial level was a crazy idea because they are so susceptible to the ambient conditions and expensive. Supporting them in a solid material opened a variety of opportunities for their reuse. Moreover, the immobilization allows increasing their thermal stability and tolerance to other industrial conditions. The enzyme – support composite materials can be used in continuous processes or allow to their reuse several times in batches. The use of inorganic materials as supports is emerging as a convenient strategy for immobilizing enzymes, because these materials are inert, exhibit mechanical stability; they are not attacked by microorganisms and they can work in a wide range of pH and temperatures either in aqueous and organic solvents.

Silica, carbon and carbon/silica composite materials are very useful for being used as support for enzyme immobilization. However, the design of synthetic routes is necessary in order to achieve the convenient porosity and chemical nature for every enzyme. It is an opened field in the materials science that highlights the importance of studying the mechanism formation of the materials and the effect of synthesis conditions. The physicochemical characterization of these materials should be exhaustive, taking into account that pore surface curvature and chemistry of the surface affect the enzyme. The enzyme-support interaction could be maximized for having a high loading if these two characteristics are well-known. Fortunately, the hydrothermal synthesis pathways allow controlling them.

Specially, the porous inorganic materials offer advantages for enzyme immobilization due to their high surface area compared with non-porous materials. The enzyme – pore geometric congruence brings positive effects on the immobilized enzyme. In order to achieve these effects, the pore diameter of the material must be at least one and a half higher than the dimension of the enzyme. The porosity of silica can be controlled by using surfactant and other additives during its synthesis. This porosity can be tuned by modifying the pH of the mixture and synthesis temperature. The resultant solid after elimination of the surfactant is a porous material. Especially, hierarchical silica with macropores combined with mesopores deserves attention. The first kind of pores allows the diffusion of the enzyme toward the mesopores that exhibit available surface area for the enzyme immobilization. The silica bears silanol groups in its surface. This confers a hydrophilic nature to the silica. Moreover, this silanol groups can be modified with different organic groups, changing the hydrophilic nature, the surface charge and the functionality of the solid. Due to the possibility of change the surface chemistry, these siliceous materials are versatile for immobilization of enzymes through adsorption, electrostatic interactions and covalent pathways.

On the other hand, the hydrophobic nature of carbon makes this kind of support very attractive for immobilization of lipases. These enzymes are active only if their lid is opened, by a phenomenon called interfacial activation. This objective is achieved due to the hydrophobic areas of the enzymes prefer the hydrophobicity of the support. The porosity of the carbon can be tailored through the synthesis and carbonization conditions.

However, a high hydrophobicity of the support has its negative face since the immobilization process is frequently done in aqueous solution. If the dispersion of the support is low, the enzyme immobilization is not efficient. The design of carbon/silica composite can help to overcome this difficulty and therefore, improve the enzyme loading. Tailoring the composition of the synthesis mixture, the hydrothermal and carbonization conditions, the proportion of silica can be modulated, which has effects on the hydrophobicity of the composite material. Generally, the porosity of this kind of materials is in the range of the microporous because it is originated by the effect of the gases generated during the carbonization process. However, the control of the hydrothermal conditions during the formation of the composite hydrochar can control the porosity of these materials towards meso and macropores. If the surfactant is present in this synthesis, the generated porosity is protected against the collapse during the carbonization.

The main objective of the enzyme immobilization is that enzyme-support composite exhibits a high thermal stability without losing activity. High immobilization efficiency is achieved by synthesizing and selecting the appropriate support combined the control of the immobilization conditions. However, the expressed activity of the enzyme almost always is lower for the immobilized form than for the free one. There are exceptions as in the case of lipases immobilized in hydrophobic materials. In this case, the activity of the composite biocatalyst is higher than that expressed by the free enzyme. The

Mesa. © All rights are reserved

Citation: Mesa M. The Immobilized Enzymes in the Composite Materials World. Ann Materials Sci Eng. 2015;2(1): 1019.

enzymes hyperactivation comes true through the immobilization process in a support with tailored chemistry. The analysis and rationalization of the enzyme – support interactions must be taken into account for obtaining these efficient bioinorganic composites. The obtention and subsequent use of an enzyme – inorganic support composite is a topic in the frontier between materials and biocatalysis.

Ann Materials Sci Eng - Volume 2 Issue 1 - 2015
ISSN : 2471-0245 | www.austinpublishinggroup.com
Mesa. © All rights reserved

Citation: Mesa M. The Immobilized Enzymes in the Composite Materials World. Ann Materials Sci Eng. 2015;2(1): 1019.