

Preface

The application of immobilized cells as well as enzymes is a common technique in contemporary biotechnological production processes. Usually, the biocatalysts are encapsulated in an artificial matrix and/or bound to a (particle) surface. A reduction of the catalyst's activity is widely accepted considering the higher lifetime and a simplified recirculation of the immobilized catalyst. One of the broad varieties of parameters affecting the activity is the utilization of chemical agents that modify the chemical surrounding as well as the physiological state in comparison to the native suspended cell. However, biofilms representing encapsulated cells in a matrix produced by their own combine the mentioned beneficial attributes and can be considered as a natural way of immobilized (whole cell) biocatalysts. Even though biofilms are predominantly associated in terms of process engineering with fouling processes resulting in a reduced process as well as product quality, their application for the production of valuables might be an interesting option which is up to now markedly underestimated. From an ecological point of view the biofilm state of a microorganism commonly represents the native growth state rather than the planktonic mode which is preferred for most bioprocesses, in particular with respect to mixing and supply of nutrients, respectively. But one has to consider that some characteristic traits of a microbial cell or a consortium of microorganisms appear solely if the organism grows attached to a surface, i.e., many prospective strains found in nature and featuring interesting product spectra often do not show this profile after transfer of the strain and its (suspended) handling in a lab. Besides a cell's expression pattern the robustness of a biofilm toward non-physiological conditions and its long-term stability is emphasized if biofilms are discussed as tools for the production of biotechnological valuable compounds. However, such utilization requires a sophisticated knowledge of several realms of basic sciences as well as engineering aspects. Some of them which are considered of tremendous importance to fulfill the broader application of biofilms within biotechnology are addressed within this issue of the "Advances in Biochemical Engineering/Biotechnology" series.

Elucidation of biofilm structure is a prerequisite to understand and to model the mass transfer and growth of cells within the extracellular matrix sheltering the cells.

Since biofilms are used for a long time in bioremediation and sewage treatment, mathematical models were developed to characterize the processes of such applications; however, state-of-the-art techniques for structure elucidation and models are presented, which might be useful to describe the corresponding processes occurring in “Productive Biofilms”. A transfer of the biofilm concept for production of valuables requires so-called synthetic biofilms, whereas the composition and architecture of the biofilm is controlled by the experimenter. How biofilm function and architecture could be controlled by artificial and/or natural means is another topic of this issue as well as the engineering of cell-to-cell communication. Communication circuits such as quorum sensing can be modified to equip the cells with specific traits or to tune the sensitivity of the communication system. Since the technical application of biofilms require a different cultivation strategy in comparison to suspended cells, an overview of biofilm reactors and materials that are currently in use or are developed is given. The selected processes can be considered as prime examples, whereby the production of a broad range of bulk and fine chemicals is presented. Moreover, the ecological role of marine and intertidal biofilms of microorganisms is addressed, including the application of such kind of biofilms and analytical techniques are presented enabling the investigation of physicochemical processes in biofilms.

This special issue bringing together the work of basic scientists and engineers which we consider as a prerequisite to facilitate the application of biofilms as biological tools for the production of valuables. We are very thankful to the authors for their valuable contributions.

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