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Ceramic based biocatalytic reactors: processing and functionalization with biocatalysts

Content

Structurally and functionally optimized ceramic materials can revolutionize many applications that rely on biocatalytic reactions. In general, the design of these materials is based on anchoring of biocatalyst phases within randomly porous ceramic supports with huge surface area within as small as possible volume. Nevertheless, the real-world applications require to address the issues related to effective mass flow and stability of anchored biocatalysts. Having this in mind, different strategies were implemented.

In order to increase surface area and permeability of reactor structure, a hierarchical porosity distribution and implementation of mass flow oriented porosity channels hold a great promise. In this study, hierarchical porosity distribution at micro – and macro- structural levels was pursued through deployment of combined freeze and robocasting techniques. The ceramic supports obtained presented high surface area and mass flow oriented channels delivering high permeability at low penalty to structural robustness.

Varying strategies were screened to achieve highly effective biocatalyst phase anchoring to ceramic support. Different chemistries of enzyme immobilization based on both reversible and irreversible biocatalyst coating were evaluated. First, surface activation with amino groups was implemented to study tailor-made enzyme immobilization based on strong ionic adsorption by anion exchange. Second, surface activation with metal ions was developed to implement metal affinity-based immobilization of engineered enzymes. Finally, surface was activated with aldehyde groups to engineer enzyme immobilization based on covalent attachment. A library of enzymes with structural diversity with technological interest were used as case study.

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