Karlsruhe Institute of Technology

Institute for Biological Interfaces
IBG-1 | Biomolecular Micro- and Nanostructures

Applications of Self-Immobilizing Decarboxylases in Flow Reactors

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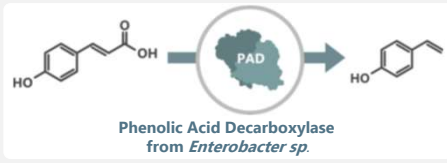
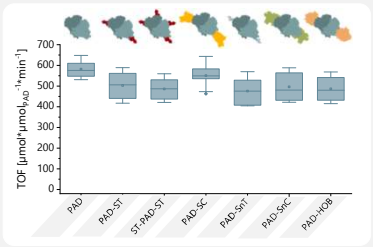
Flow systems are becoming a major focus in organic chemistry, while at the same time the interest in integrating biocatalysis is growing. Novel, flexible reactor concepts based on innovative immobilization techniques and biocatalytic materials are needed.[1]

Phenolic acid decarboxylases (PADs) enable the synthesis of industrially relevant styrenes from lignin-derived phenacrylates and thus the valorization of lignin product streams.
Therefore, we used a dimeric, highly active and stable PAD from *Enterobacter sp.*

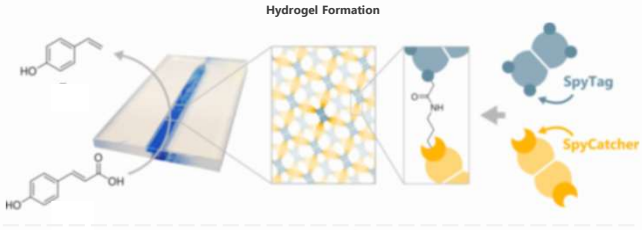


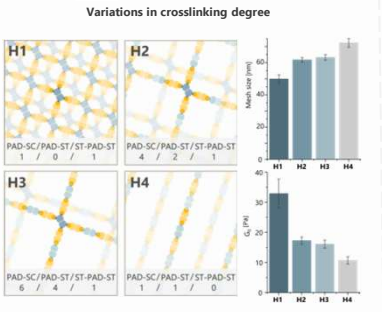
Peptide binding tags can be genetically integrated and allow self-immobilization of PAD without significantly affecting activity.

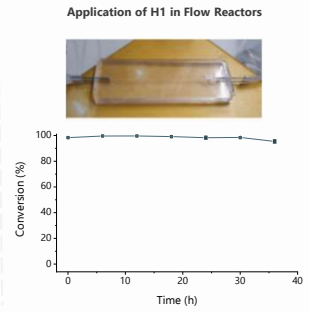


All-Enzyme Hydrogels

All-enzyme hydrogels are covalently crosslinked upon mixing via the genetically encoded SpyCatcher/SpyTag system. Attachment of one or multiple binding sites allow the use of mono- and multimeric enzyme building blocks, while variations in the stochiometric ratios of multimeric fusion partners allows for the modulation of crosslinking degree and thus rheological properties.[2]

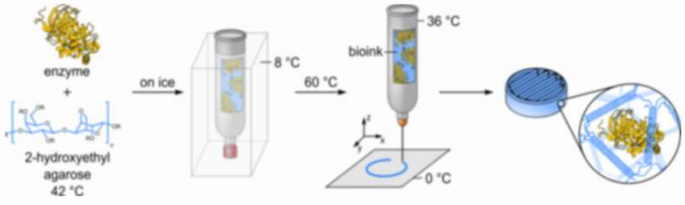






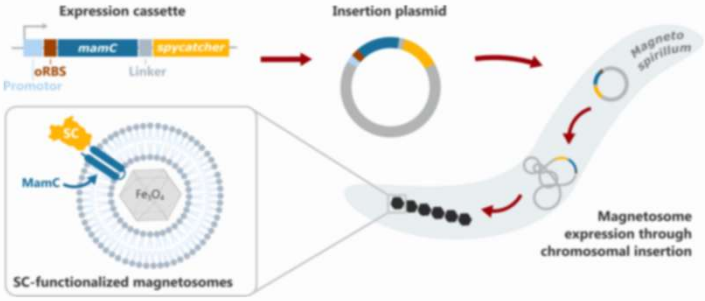
3D-printed Flow Reactor Modules

Unmodified thermostable enzymes are encapsulated in a 3D printed, agarose-based thermoreversible hydrogel and could be applied for continuous production of isopropanol or hydroxystyrenes.[3]

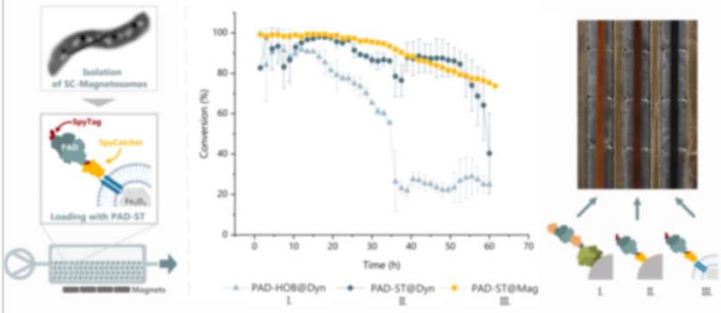


Enzyme Immobilization on Biogenic Magnetic Nanoparticles

The display of SC-connectors on the surface of genetically engineered bacterial magnetosomes generates a multimodal platform for the immobilization of foreign protein cargo.



The immobilized PAD showed superior stability. In flow systems, the PAD-loaded SC-magnetosomes (PAD-ST@Mag) outperformed similarly functionalized commercial particle formulations.[4]



SC-Magnetosomes were provided by Frank Mikoleit from the lab of Dirk Schüler, University of Bayreuth.

[1] T. Peschke, P. Bitterwolf, S. Hansen, J. Gasmi, K. S. Rabe, C. M. Niemeyer, *Catalysts*, **2019**, 9, 164.

[2] E. Mittmann, S. Gallus, P. Bitterwolf, C. Oelschlaeger, N. Willenbacher, C. M. Niemeyer, K. S. Rabe, *Micromachines*, **2019**, *10*, 795.

[3] M. Peng, E. Mittmann, L. Wenger, J. Hubbuch, M. K. M. Engqvist, C. M. Niemeyer, K. S. Rabe, *Chem-Eur. J.* **2019**, 25, 15998.

[4] E. Mittmann, F. Mickoleit, D. S. Maier, M. A. Klein, C. M. Niemeyer, K. S. Rabe, D. Schüler, *ACS Appl. Mater. Interfaces*, **2022**.

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