ILLUMINATE
Cascade reactions in flow: a novel process window in fine chemicals synthesis*

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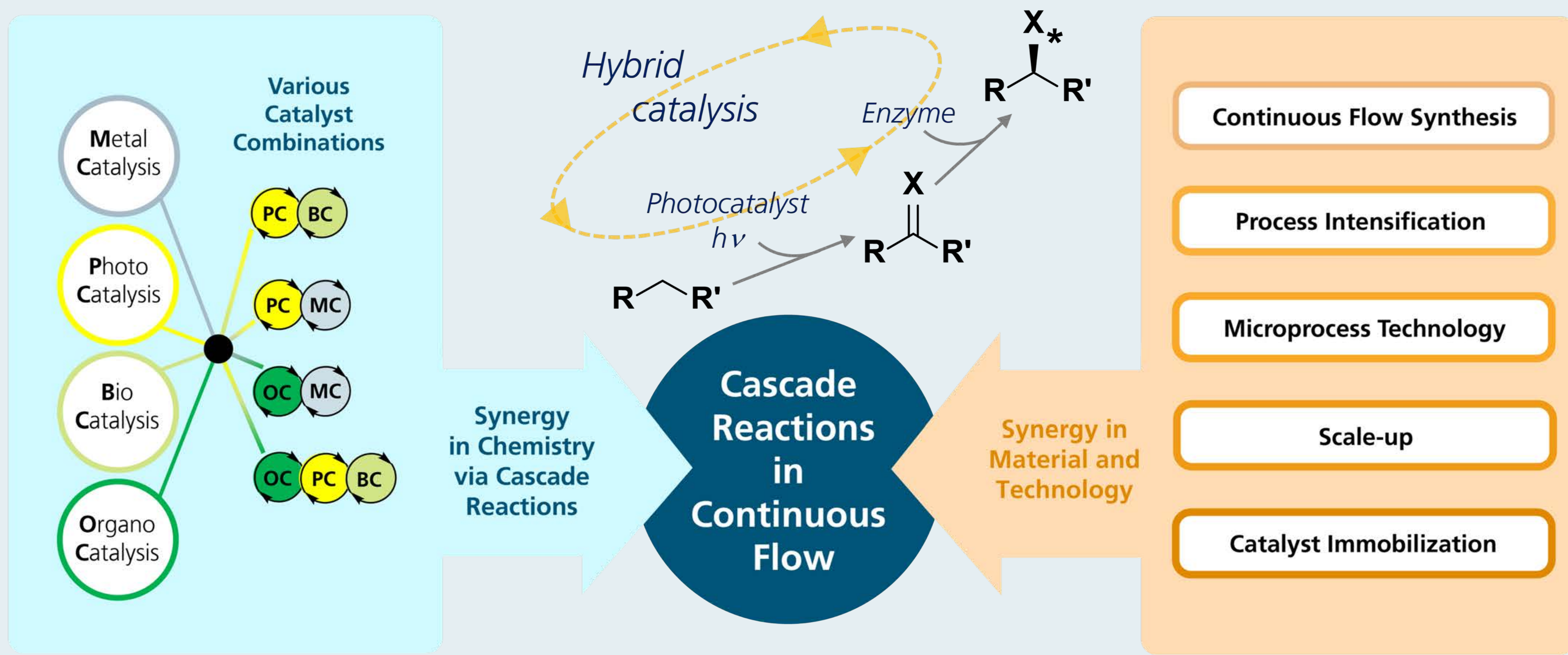
* https://www.cascade-reactions.de

Relevance of research

In recent years, cascade reactions have become a highly interesting topic of academic research. Such multi-step chemical transformations have the potential of high synergy by combining different catalysis methods within one reaction sequence. A particular interesting synergy results from the combination of photocatalysis and biocatalysis as both methods perform under mild process conditions and can provide reactive intermediates via photocatalysis with subsequent usage in the enzymatic step. In the ILLUMINATE project, a consortium of four Fraunhofer institutes investigates the transfer of photo- and biocatalyzed cascade reactions from batch to flow by developing novel multi-step catalyst materials and continuous flow reactors.[1]



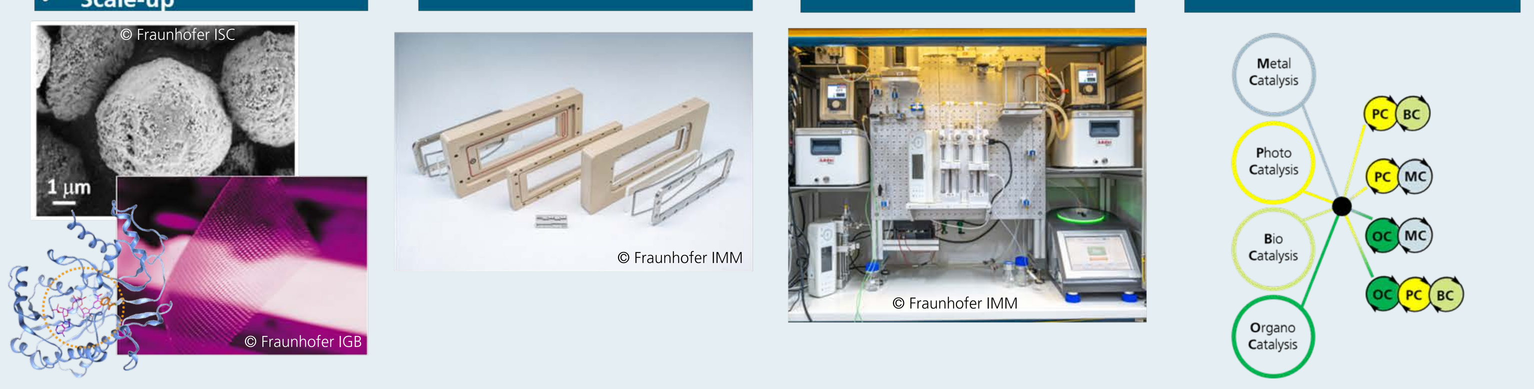
A modular platform technology for cascade reactions

Catalysts (1)
- Selection and development of catalysts
- Hybrid catalysts
- Immobilization on surfaces
- Scale-up

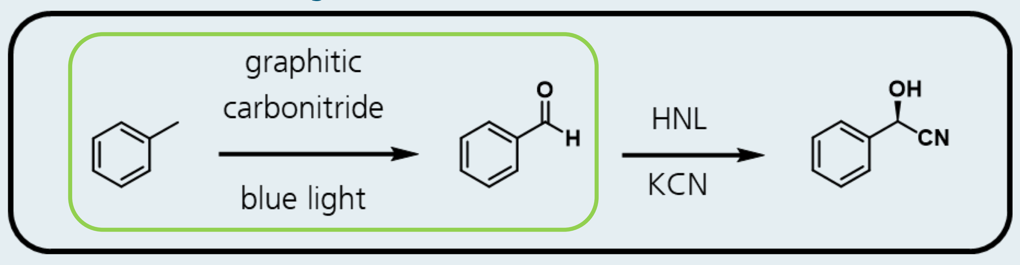
Flow reactors (2)
- Development of customer & process specific reactor systems
- Reactor scale-up

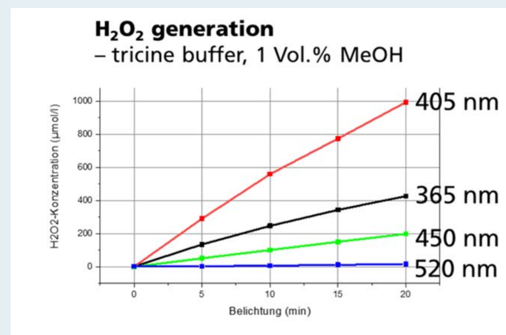
Synthesis plants (3)
- Development of customer & process specific plants
- Integration of analytics and control elements

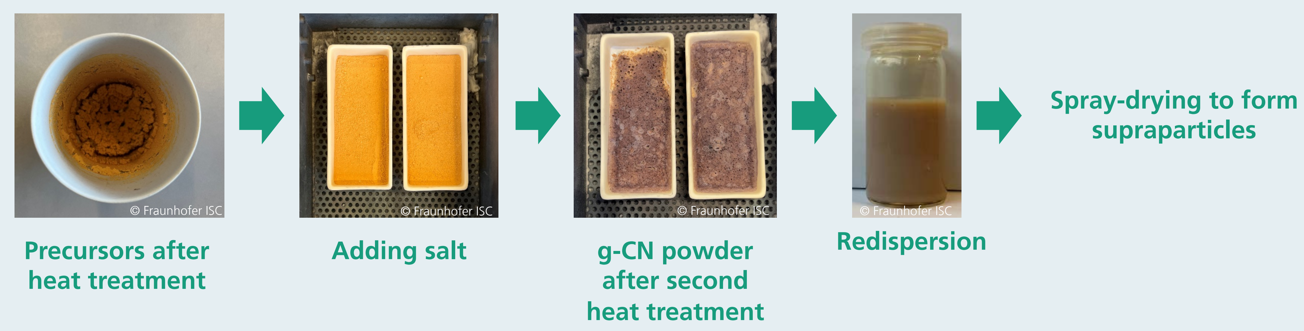
Process development (4)
- Process evaluation
- Transfer from batch to flow mode
- Cascade reactions



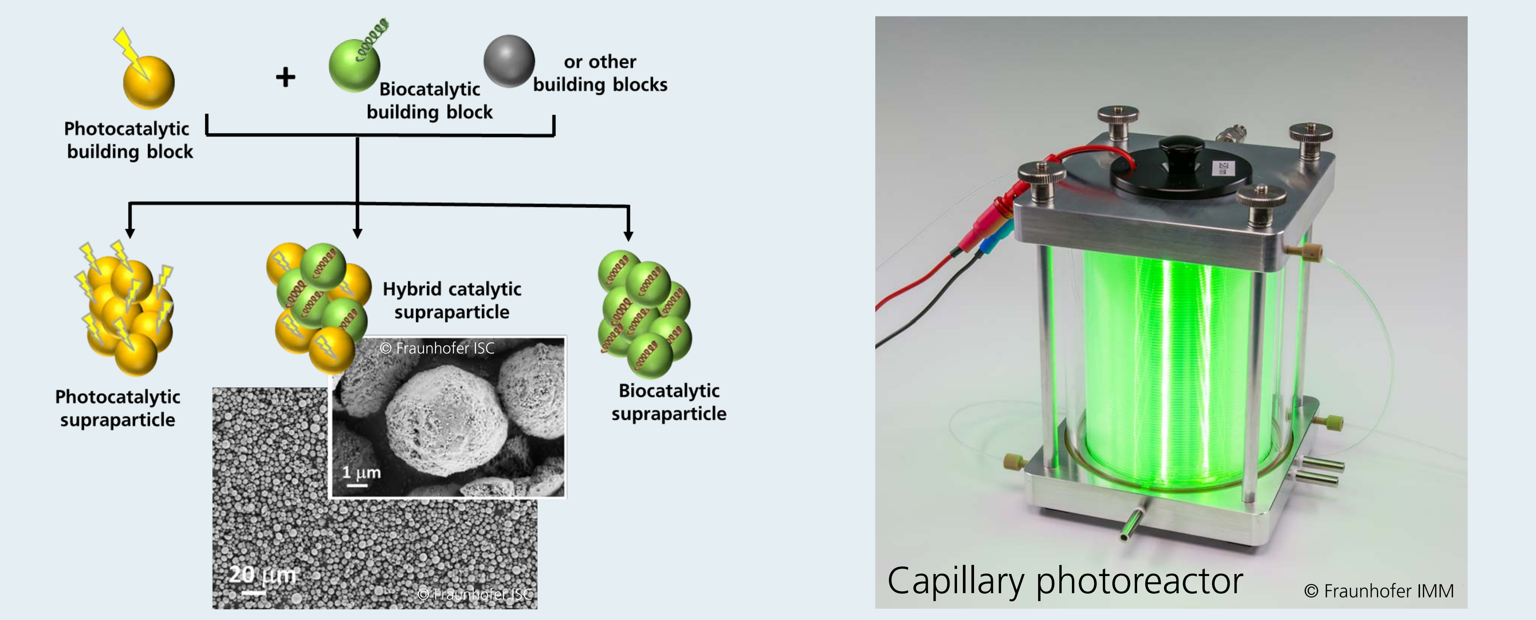
On the way to cascade reactions in flow
Photocatalytic reaction



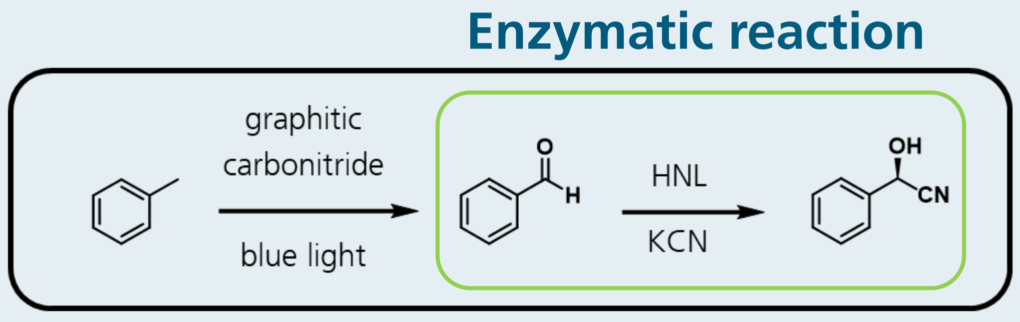


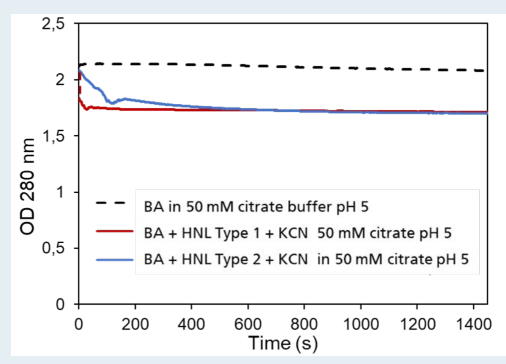


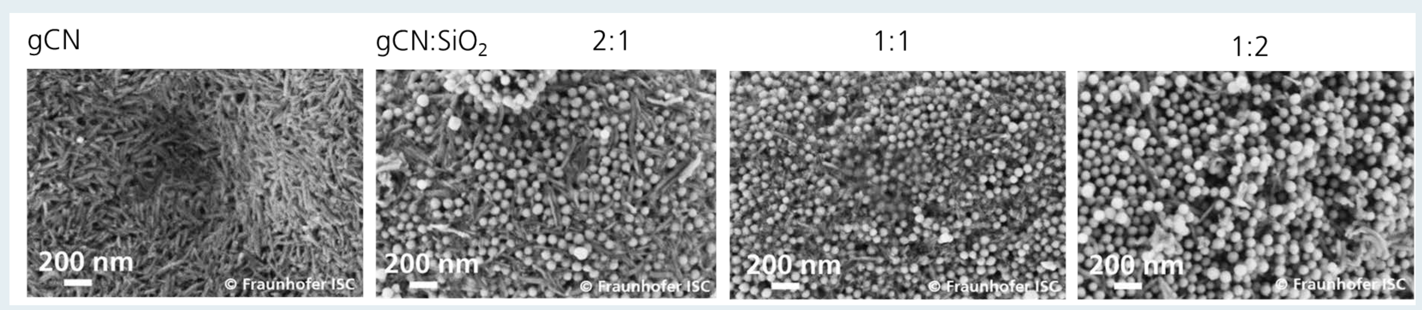
The catalyst technology 1 – Supraparticles for capillary reactors



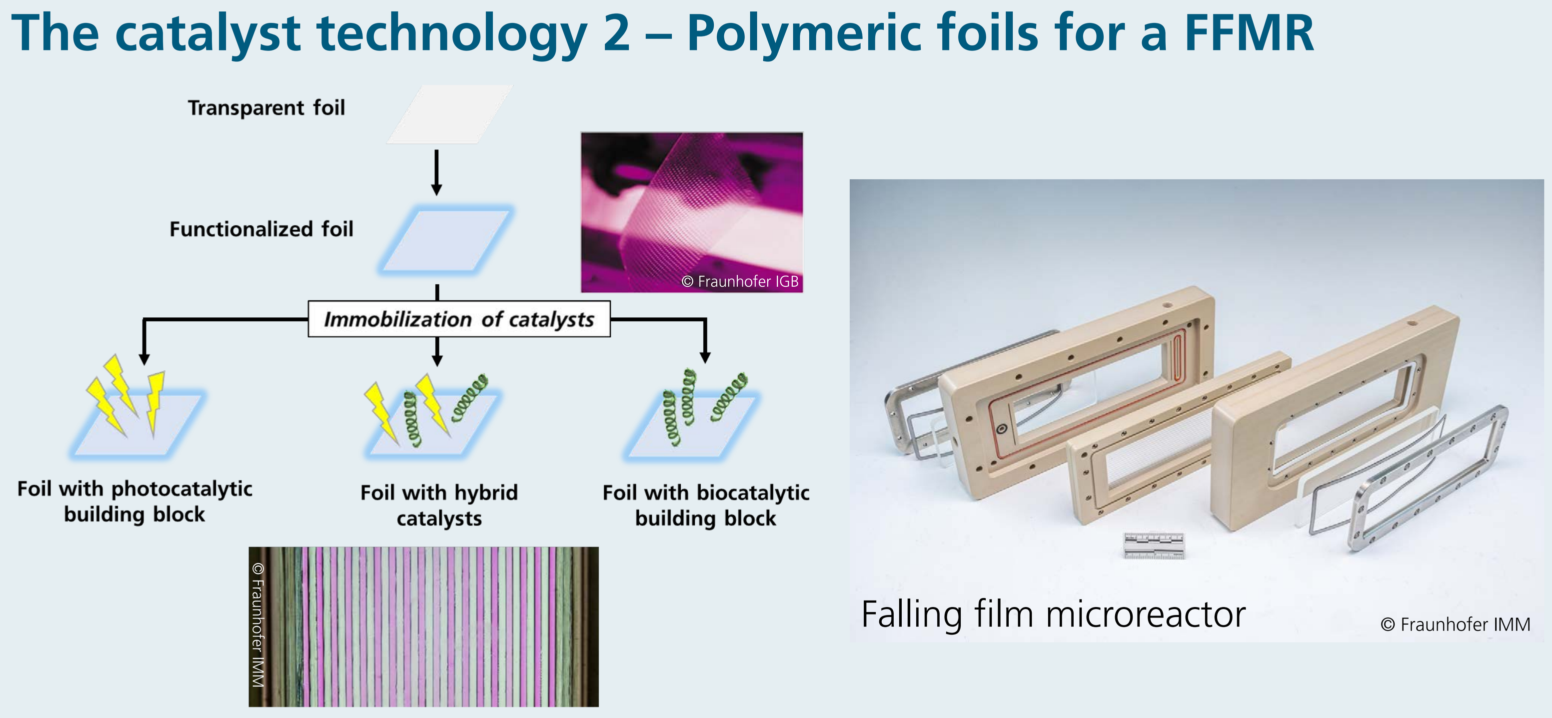
On the way to cascade reactions in flow
Enzymatic reaction







The catalyst technology 2 – Polymeric foils for a FFMR



Outlook

- Immobilization of enzymes on carrier particles and polymeric foils
- Process optimization with hybrid catalysts in continuous flow
- Scale-up of catalyst material
- Flow reactor characterization utilizing cascade reactions
- Technology and catalyst transfer to other industrial relevant syntheses of fine chemicals and APIs

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