Fine Bubbles for biocatalytic Processes

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Introduction

- In industrial chemical transformation, the perception of gas/liquid reactions in view of mass transport phenomena is of major importance. Therefore, the demand for new technologies with high mass transfer performance, low pressure drop, low shear stress and avoidance of foaming to overcome limitations of conventional aeration systems is high [1]. One possibility to achieve these goals is the aeration with fine bubbles, whose diameter is by definition less than 100 micrometers.

Aim

- Establishment of fine bubble technology to overcome limitations of conventional aeration systems.

What are Fine Bubbles?

- fine bubbles are defined by the **ISO/ TC 281**.
- **Microbubbles:**

  diameter: ca. 1〜100 µm
  motion: rising very slowly
  observation: visible
- **Ultra Fine Bubbles:**

  diameter: less than typically 1 µm
  motion: only Brownian movement
  observation: invisible

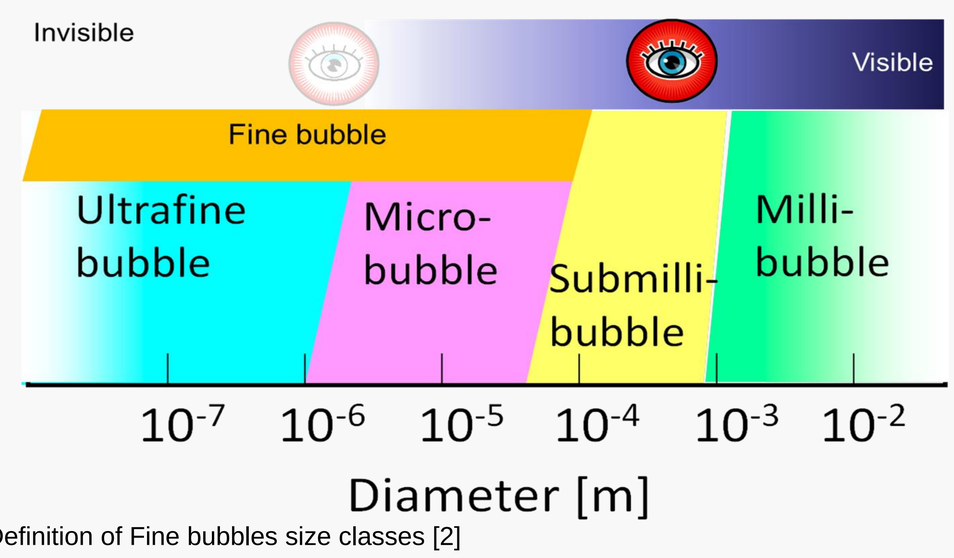

Fig. 1: Definition of Fine bubbles size classes [2]

Rising velocity

- rise velocity depends on the bubble size
- high dissolution rates due to high residence times with decrease of the bubble diameter

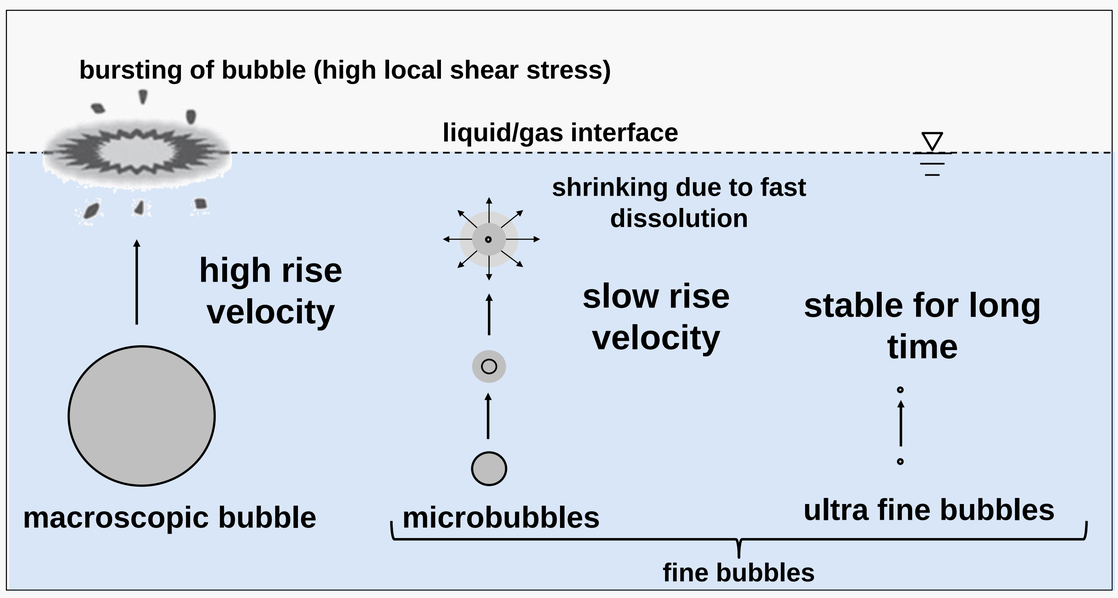

Fig. 2: comparison of rise velocity

Mass Transport Limitation

- fast reaction rate get slowed down by the speed of mass transfer

$$v_{reaktion} = k \cdot \cancel{c_{A_{Substrat\ in\ liqid}}} \cdot c_{B_{component\ from\ the\ gas}}$$

- if $c_{A_{Substrat\ in\ liqid}}$ is in excess and the $\cdot\ c_{B_{component\ from\ the\ gas}}$ the reaction speed only depends on $\cdot\ c_{B_{component\ from\ the\ gas}}$

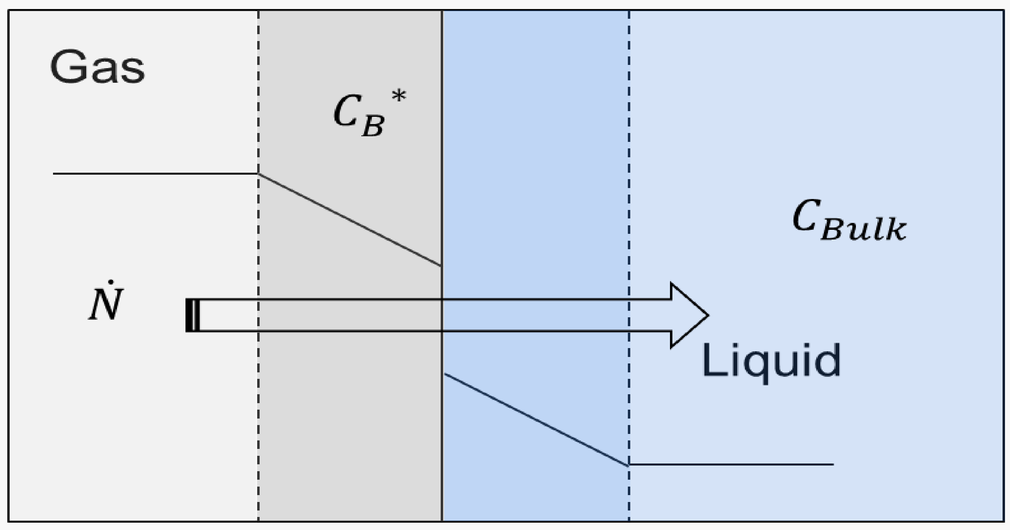

Fig. 3: mass transport from the gas to the liquid phase

➢ **gas to liquid mass transfer is the key!**

DFG Project “Fine Bubbles”

- focuses on applications in chemo- and biocatalytical reactions due to overcome limitations of conventional aeration systems
- comparison of conventional and fine bubble aeration systems in view of mass transfer performance, pressure drop, shear stress, foaming tendency, coalescence and break up behavior
- investigations of different reactor types with the focus on stirred tank and packed bed reactors as well as bubble columns being carried out

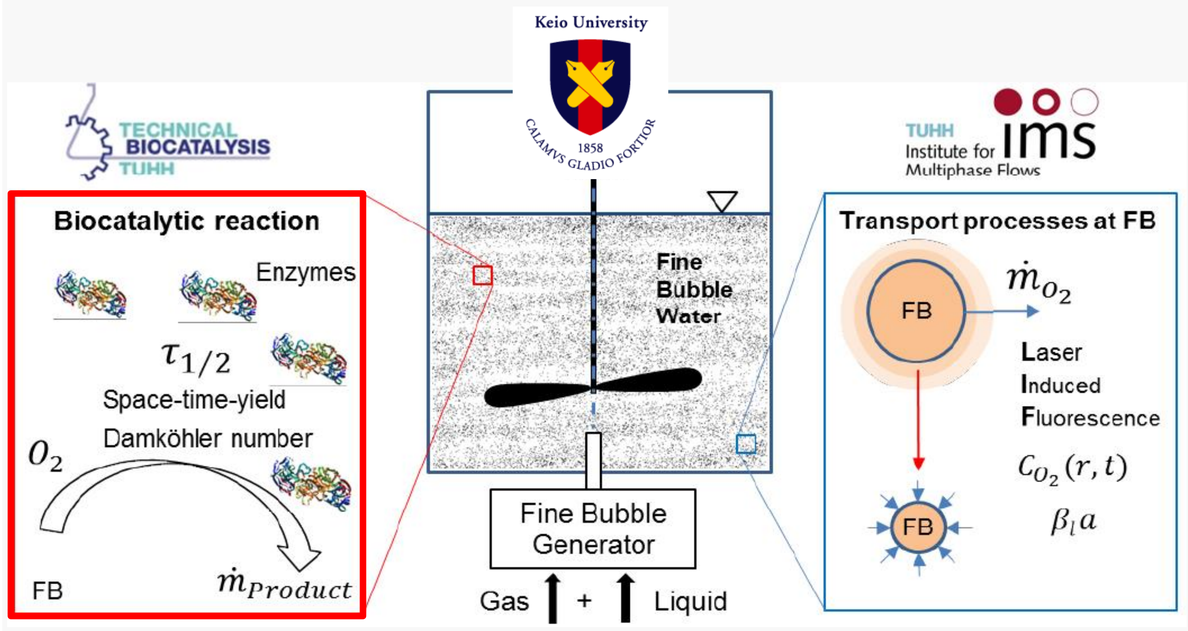

Fig. 4: deviation of the research area in the DFG- Project “Fine Bubbles”[3]

Summary

- overcome limitations of conventional aeration systems with the focus on chemo- and biocatalytical reactions
- comparison of conventional and fine bubble aeration systems
- further characterization and application of model system is under investigation

References:

[1] Tsuge, Hideki. Micro- and nanobubbles. Boca Raton, Florida : CRC Press; Pan Stanford Publishing, (2015).

[2] Presentation fine bubbles Prof. Terasaka, TUHH, 20.02.2017.

[3] DFG-Proposal Projekt Fine Bubbles, 2016, Prof. Schlüter, Prof. Terasaka, Prof. Liese, Sven Kastens

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