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「機械システム・イノベーション」

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Multiphase microfluidics, with applications to fermented beverages and polymeric microparticles

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Microfluidics is a term with wide and loose meaning. With multiphase microfluidics, I mean the study of processes involving multiples fluid phases bounded by a solid microgeometry. Micro- and nanoscale dimensions allow to accelerate diffusive transport and to manipulate Laplace pressure forces for e.g actuation with microbubbles, or selective transport through membranes or porous materials. Here, we describe challenges associated with the development of the smallest and fastest winery. This project stems from considerations on the diffusion-limited fermentation rates of conventional bioreactors. We describe a micro/nanofluidics technology [1] which reduces diffusion lengths, accelerates the fermentation time to about one hour, and allows unprecedented control of the fermentation parameters. Opportunities and challenges of the technology for winemaking will be discussed, including possible applications to Japanese fermented beverages such as Kombucha and Sake. We then describe how segmented flow – the generation of biphasic trains of plugs and slugs along microchannels – can be used to enhance heat transfer [2] and manufacture microparticles of polymeric materials [3] with better size control than processes based on emulsion.

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