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Title:
Microfluidics and carbon dioxide

Abstract:
Gas-liquid reactions and physical processes involving carbon dioxide (CO2), one of the most important green house gases, are of great practical and fundamental importance. To generate new, efficient catalysts and optimized chemical formulations for CO2 sequestration, fundamental knowledge has to be developed on the mechanisms of gas-liquid reactions, their kinetic and thermodynamic characteristics and physical CO2-related processes, e.g., extraction and phase separation. Current methods to study reactions of CO2 are challenging, due to the mass-transfer limitation and a poorly defined interface between the gas and liquid phases.

We developed a microfluidic platform that relies on the microfluidic generation of highly monodisperse gas bubbles (plugs) separated with liquid droplets (slugs) and subsequent analysis of the time-dependent changes in bubble dimensions, as well as the characteristics of liquid-liquid phase separation mediated by CO2 reactions. We present the applications of this platform for exemplary reactions of CO2 with amines and Frustrated Lewis pairs. The microfluidic platform enables rapid determination of reaction rate and equilibrium constants, conversion, kinetics and completeness of phase separation, thermodynamic properties and screening of different reagents.

The CO2-based platform has also been utilized in materials science for the generation of uniformly sized bubbles coated with colloidal micrometer-size particles, polymers or nanoparticles. Potential applications of these bubbles will be demonstrated.