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Continuous Flow Chemistry under High-Temperature / High-Pressure Conditions

D. OBERMAYER [1], T. N. GLASNOV [1], T. RAZZAQ [1], M. IRFAN [1], M. DAMM [1], C. O. KAPPE [1]

Christian Doppler Laboratory for Microwave Chemistry and Institute of Chemistry, Karl-Franzens-University, Graz, Austria

E-mails: oliver.kappe@uni-graz.at (C. O. Kappe)

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Continous flow processing is a key enabling technology when it comes to scale-up microwave synthesis protocols to production scale quantities [1, 2].

Organic chemistry in microreactors, being generally characterized as chemistry in miniaturized reaction devices, comprising channel diameters below 1000 µm have many benefits. Mixing and heat transfer are exceptionally fast on the microscale, taking advantage of very short diffusion paths and a very high surface-to-volume ratio, which enables a very efficient heat transfer in both directions, flash heating, as well as excellent process control. Strongly exothermic reactions as well as transformations involving hazardous reactants or products can be handled safely on a large scale.

Very notably, microreactor techniques can be used to overcome the scale-up limitations inherent to high-speed microwave batch processing in sealed vessels. Vice versa, microwave reactors can be used for rapid reaction optimization for a given transformation conducted under continuous flow conditions, since the reaction time at a certain temperature obtained in a microwave reactor can be directly translated to a residence time in a flow reactor. An established flow process is readily scaleable (in contrast to a batch process) by either extending product collection time, increasing the length of microchannel (thereby allowing for a higher flow rate), parallel operation of many identical channels (“numbering up principle”), or by a combination of these principles [3].

We will present how continuous flow processing can be realized in meso-fluidic flow devices featuring stainless steel tubes, allowing for an exceptionally high operating window of up to 350 °C and 180 bar working pressure. Microwave reactors were advantageously used for rapid modification and optimization of the reactions conducted in flow reactors and directly transferred to continuous flow conditions.

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