Our Journey in the Use of Continuous Flow Methods for Sustainable Chemical Synthesis

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Today, it is widely accepted that flow reactors offer precise control over reaction parameters, enhancing selectivity and scalability in chemical synthesis compared to traditional batch methods. These streamlined continuous processes not only improve efficiency and reduce waste, but also contribute to increased sustainability. My talk will spotlight the critical role of flow reactors in modern synthesis, highlighting their benefits over conventional batch techniques. Drawing inspiration from our academic-industrial collaborations, I will present three case studies: the continuous-flow synthesis of pharmaceutically relevant oxiranes (and closely related derivatives) from biomass-derived glycerol, the flow photoredox coupling of aryl and alkyl bromides with carboxylic acids over heterogenized catalysts, and the trifluoromethylation of highly functionalized arenes, emphasizing the advantages of precise reaction control and higher selectivity from the use of flow conditions. Novel flow reactor designs obtained through the employment of additive manufacturing will also be presented, with a focus on intensified operation and enhanced productivity. Finally, I will complement this discussion with a quantitative sustainability analysis, illustrating the environmental advantages of flow reactions over batch processes. This will offer valuable insights into advancing sustainable and efficient flow chemical synthesis.