MicroChemical Systems–Multiphase Reactions

Personnel

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Many chemical reactions involve multiple fluid phases, such as gas (G), immiscible liquids (L) in the presence of solid catalysts (S). However, in contrast to the large number of single-phase applications of microfluidics devices, only recently, multiphase reactions – particularly gas-liquid systems – have been used in microchemical systems in a systematic way. Based on a detailed description of the flow physics and the reaction chemistry, we aim at providing a systematic understanding and design rationale for multiphase reactors.

Unlike for the predicting miscible or immiscible liquid-liquid systems in microchannels, the velocity field and phase distribution of gas-liquid flows are computationally accessible only from approximate solutions of the governing equations. However, if the flow regimes can be reliably predicted, such flows offer unique opportunities. Intense interfacial contact provides a large interfacial area and improves mass transfer within the phases compared with molecular diffusion. A physical description of such flows in terms of the flow regime, pressure drop and interfacial area, quantities that are linked to the mass transfer characteristics, relies on experimental studies. Studies are carried out for developed gas-liquid flows with varying inflow conditions and geometry. Quantitative flow visualization methods are being used and sensors will be incorporated into flow passages that allow for the local determination of the flow regimes and void fraction. Several applications of multiphase flows are being pursued, including hydrogenation, oxidation, and materials synthesis.

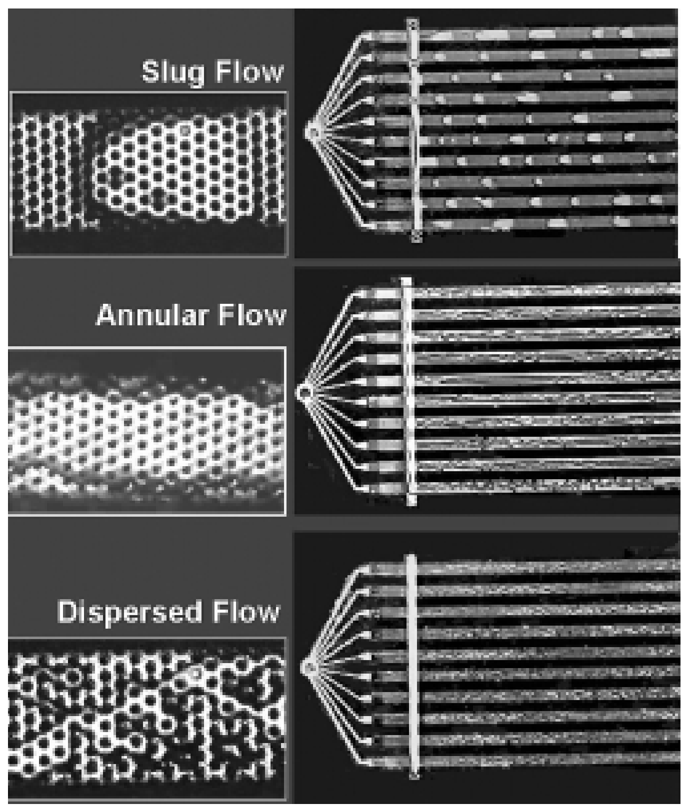

Fig. 40: Examples of multiphase flows in a ten channel microreactor with silicon posts in the reactor channels. Reactors (right) and detail of flow in channel (left).