Organic Synthesis in Microreactor Systems
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Enhanced heat and mass transfer, reduced reaction volume, and the ability to run several experiments in parallel render microreactors powerful instruments for scanning and optimizing chemical reaction conditions. Furthermore, the high mechanical strength and thermal conductivity of silicon microreactors permit the exploration of organic syntheses at higher temperatures and pressures than can be achieved with conventional bench-scale equipment. An example of these benefits is demonstrated in the aminocarbonylation reaction study [1]. Traditionally, these reactions are performed at atmospheric conditions and with temperatures at or below the boiling point of the solvent (toluene, 110°C). However, in silicon microreactors (Figure 1), it is possible to reach pressures exceeding 100 bar [2] and temperatures above 800°C [3]. Exploration of the aminocarbonylation reaction offers information that can be useful for the optimizing selectivity of the synthesis; higher CO pressures enhance α-ketoamide formation and increased temperatures favor amide formation.

Once the chemical reaction is complete, it is desirable to separate the toxic gas from the liquid phase. Although negligible on the macro-scale, surface forces play a dominant role in microfluidics. Creating a capillary-based system (Figure 2) [4] makes it possible to take advantage of these forces. The liquid phase wets the capillaries and prevents the gas from penetrating the capillary matrix through the proper adjustments of pressure drops across the separator. Similarly, this concept can be applied to heterogeneous reactions that involve two immiscible liquids. Due to this micro-technology, microreactor systems can be assembled for multi-step synthesis and separation that could not easily be achieved in traditional laboratory environments. As a result, high throughput experiments can be performed and entire chemical processes can be optimized efficiently with microreactor systems.

**References**