The last enabling technique for confining the crystallization environment uses emulsions. An emulsion is a mixture of at least two immiscible liquids in which one is the liquid phase dispersed in a continuous liquid phase. The emulsion droplets (each acting as an independent crystallizer) can be prepared with a uniform and controllable micro- to nano-scale size using high energy (mechanical) and low energy (chemical) methods.[158–161] Emulsions can also be produced using microfluidic devices.[159,162–165] In general, emulsion crystallization is employed for the production of micro- and nano-sized crystals within confined spaces,[144,166,167] encapsulation and delivery of substances,[158,168–170] as well as screening of crystallization conditions.[171–173] However, the concept of continuous emulsion crystallization, to the best of our knowledge, is in its beginnings[165,174] and deserves more attention as a PI strategy.

7.3.2.1 Microfluidic Devices

Microfluidic flow devices are ubiquitous in the scientific literature because they provide a unique environment for the study of crystallization processes at the meso or nano scale with precise control over process parameters.[175] However, due to the propensity of solid phases and precipitating systems to block small channels associated with microfluidic devices, the type of applications are limited. In general, the microfluidic technique as a PI approach is not sufficiently scalable for separation and purification of reaction streams in commercial activities that require isolation of target products. On the other hand, microfluidic crystallization provides the capacity to explore hundreds of experimental conditions through a single experiment while minimizing the consumption of precious substances, which cannot be achieved with conventional crystallization processes. Therefore, microfluidic crystallization is primarily associated with screening of crystalline forms[176,177] and extraction of kinetic information for crystallization including proteins[178–181] and not for continuous isolation and purification from reaction streams. Droplet-based microfluidic applications using the concept of emulsion crystallization may provide a route to access a wider microfluidic crystallization aimed at producing tailored spherical particles for small-scale production of formulated drugs.[165] Recently, Shi *et al.*[175] provided a review of the state of the art in the field of crystallization under microfluidic flow.

7.4 Function Domain

The implementation of multiple processing functions into one single physical space is another PI principle in crystallization.[11] Any unit operation for separation and purification has its thermodynamic, kinetic, and economic boundaries within which they can operate optimally. However, combining different unit operations (functions) offers the potential to exceed the