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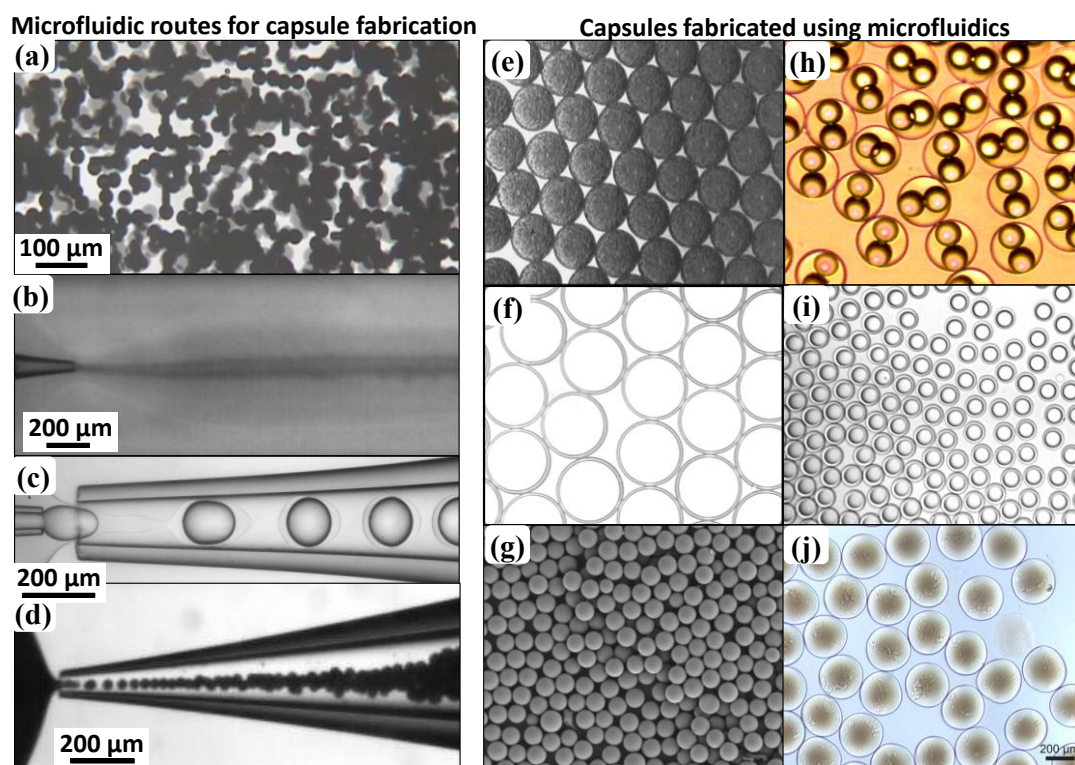
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# Application of microfluidics and monodispersed emulsions to controlled release and digestibility studies

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Microfluidics enables fabrication of monodisperse droplets and capsules that can be used for fundamental studies on controlled release and digestion. We have fabricated multiple W/O/W emulsions using single capillary flow focusing microfluidic device (Fig. 1d) and the scale-up was achieved using silicon straight-through microchannel plate containing more than 23,000 asymmetric microchannels (Fig. 1a). Core/shell droplets with controllable shell thickness (Fig. 1f) or multiple emulsions with controlled number of inner droplets (Fig. 1h) have been generated using capillary device that combines co-flow and flow focusing (Fig. 1c). To provide sustained release, droplets were converted into solid particles by gelation (Fig. 1j) or solvent evaporation (Fig. 1g). We have also fabricated phospholipid (PL) nanoparticles by injecting PL-loaded ethanol phase into co-flowing aqueous buffer solution (Fig. 1b) [2].



**Figure 1** Microfluidic emulsification routes for capsule fabrication (left): (a) Microchannel array device; (b) Solvent diffusion in co-flow; (c) Combination of co-flow and flow focusing; (d) Flow focusing. Examples of capsules fabricated using microfluidics (right): (e) Multiple emulsions; (f) & (i) core/shell drops with a diameter of 78  $\mu\text{m}$  a shell thickness of 8  $\mu\text{m}$ ; (g) Poly(*dl*-lactid acid) capsules; (h) multiple emulsion drops containing two inner drops per each outer drops; (j) Chitosan capsules.

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## References

- [1] G.T. Vladisavljević, H.C. Shum, D.A. Weitz, *Prog. Colloid Polym. Sci.*, 139 (2012).
- [2] A. Laouini, C. Charcosset, R.G. Holdich, G.T. Vladisavljević, unpublished.