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Goran T. Vladisavljević

Chemical Engineering Department, Loughborough University, Loughborough LE11 3TU, United Kingdom

G.Vladisavljevic@lboro.ac.uk

We have produced size-tunable nanoparticles with narrow particle size distribution by micromixing combined with nanoprecipitation using two different microfluidic devices: (i) membrane contactors consisted of a nickel microengineered membrane with a pore diameter between 5 and 20 μm and pore spacing of 80 or 200 μm fabricated by UV-LIGA process[1] and (ii) co-flow glass capillary devices consisted of coaxial assembly of round and square glass capillaries placed on a microscope slide[2]. A variety of different nanoparticles have been produced, including gold nanoparticles, polycaprolactone nanoparticles loaded with nanoclay nanopowder, biodegradable micelles from poly(ε-caprolactone)/poly(ethylene glycol) diblock copolymers and liposomes. Typically, the organic phase containing particle-forming material and hydrophobic active was injected through the membrane pores into the aqueous phase and the particles were formed as a result of controlled interpenetration of two miscible solvents. A shear rate at the membrane/aqueous phase interface was controlled by stirring, cross flow or membrane oscillations. Alternatively, the organic phase was injected through a tapered inner capillary into a co-flowing aqueous phase in the outer square capillary. Gold nanoparticles were formed by reduction of tetrachloroaurate (III) with ascorbic acid and the reactants were delivered with two coaxial aqueous phase streams generated in glass capillary devices.

The size of nanoparticles produced in membrane contactors was precisely tuned by controlling the membrane pore size, the shear rate on the membrane surface and the aqueous to organic phase volume ratio. In glass capillary devices, the particle size was controlled by the flow rates of the two streams and the orifice size of the injection capillary.

References

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