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Preparation of 10 μm scale monodispersed particles by jetting flow in coaxial microfluidic devices

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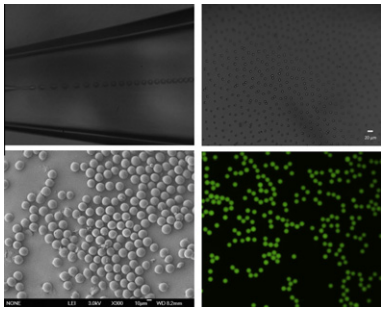
HIGHLIGHTS

- A novel and facile microfluidic method to generate various 10 μm scale monodispersed particles was developed.
- Functional additives such as fluorescent dye were added into monomer droplets to generate functional fluorescent particles.
- The microfluidic method is versatile to various materials to generate polymer and hydrogel particles.

GRAPHICAL ABSTRACT



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ABSTRACT

Ten microns scale monodispersed particles have a widespread use in various applications. In this work, we developed a novel and facile microfluidic method to generate various 10 μm scale monodispersed polymer and hydrogel particles. The method involves the formation of monodispersed droplets by using stable jetting flow in a simple coaxial microfluidic device and solidifying the droplets in situ. We also added functional additives such as fluorescent dye into monomer droplets to generate functional fluorescent particles. The microfluidic method presented here is versatile to various materials and can add functional additives to form functional microparticles.

1. Introduction

Ten microns scale monodispersed particles have been widely used in various applications, such as toners, standard particles for instrument calibration, column packing materials for chromatography, spacers for liquid crystal displays, and materials in biomedical and biochemical analysis [1–5]. However, monodispersed particles with uniform size in the range of 1–10 μm were usually difficult to obtain because this size is in-between the diameter range of particles produced by conventional methods such as emulsion polymerization, miniemulsion polymerization and suspension polymerization [5–7]. Thus, some special methods such as successive seeding method [8], two-stage swelling method [9], SPG emulsification modified suspension polymerizations [10–12] and dynamic monomer swelling method [13] were developed to generate monodispersed particles with uniform size in the range of 1–10 μm. The methods above may suffer from the problems such as phase separation, poor particle size control and complex fabrication procedures. Dispersion polymerization was developed as an attractive method that produces monodispersed particles in a single batch process [5,7,14–17]. However, the mechanism of particle formation is quite complicated since it usually starts with a homogeneous solution of monomer with initiator and dispersant, and

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