Efficient Generation of PLGA Particles Using the Dolomite Mitos System for Precision Drug Delivery Applications

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Introduction

Poly(lactic-co-glycolic acid) (PLGA) particles are extensively utilized in the biomedical field for controlled drug delivery, due to their biocompatibility and biodegradability. This study highlights the capabilities of microfluidic systems such as the Dolomite Mitos System in producing uniformly sized PLGA particles, crucial for predictable pharmacokinetics and pharmacodynamics in targeted therapies.

Method

Equipment and Setup:

The Dolomite Mitos System, equipped with 3D flow focusing chips with variable junction sizes ranging from 30 µm to 170 µm, was utilized to synthesize PLGA particles. Figure 1 shows the schematic workflow of the Dolomite Mitos System, including the PLGA application pack for lab-scale particle synthesis, pressure pumps, flow rate sensors, 3D flow focusing chips, and a tubing kit with essential accessories.

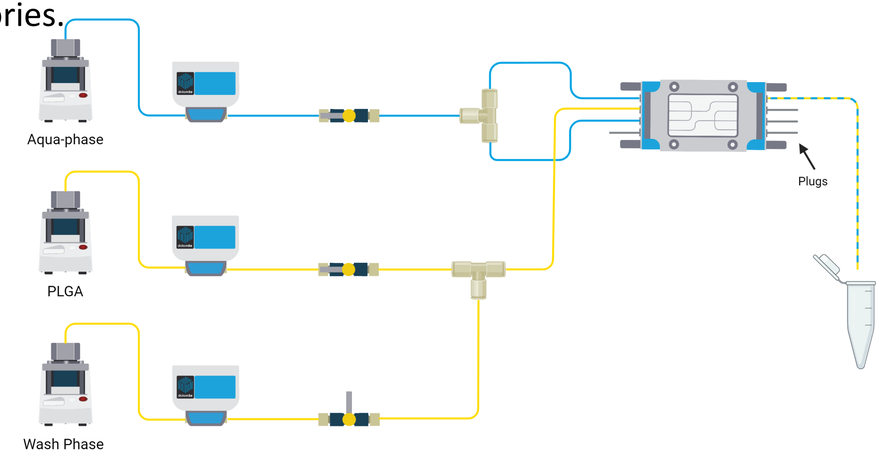

Figure1. Schematic workflow for Dolomite Mitos System with a PLGA application pack

Procedure:

Flow rates and polymer concentrations were adjusted to optimize particle size and distribution. The following conditions were used:

- **Droplet Phase:** 1%, 3%, and 10% (w/v) PLGA concentrations in Ethyl Acetate.
- **Carrier Phase**: Aqua-phase, a Dolomite product.
- **Wash Phase:** Pure Ethyl Acetate.

All liquids were filtered prior to use. The microfluidic setup of the Dolomite Mitos System facilitated the production of uniformly sized PLGA droplets, as illustrated in Figure 2. The precision in controlling shear forces and solvent extraction was evaluated to ensure the reproducibility and scalability of the particle fabrication process.

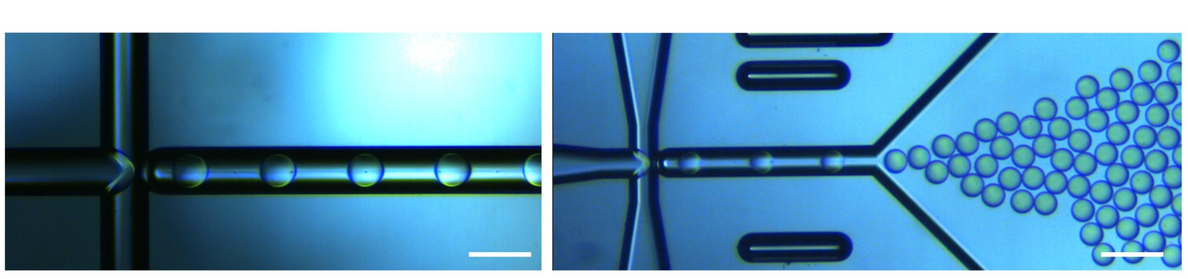

Figure 2. 100 µm (left) and 65 µm (right) 3D flow focusing chips producing monodisperse PLGA droplets in Aqua-phase. Images were taken under Dolomite High-Speed Microscope and Camera. Scale bar = 200 µm

Characterization:

Particles were characterized using both optical microscope and scanning electron microscopy (SEM) to validate their size distribution and morphology.

Conclusion

The Dolomite Mitos system with a PLGA application pack is a robust and scalable tool for generating PLGA particles, providing precise control over particle size and distribution, critical for advancing targeted drug delivery. This technology promises significant advancements in the development of next-generation micromedicines, enhancing both the design and functionality of drug delivery systems.

Result

Optimized conditions yielded PLGA particles ranging from 1 µm to 75 µm in diameter, with a coefficient of variation (CV) below 5%, indicating high uniformity. These production conditions were shown to be reproducible and scalable across multiple batches. A range of PLGA particle sizes produced using different 3D flow focusing chips in the Dolomite Mitos System was showed in Figure 3A. Each bar represents the range of particle sizes obtained, illustrating the system's capability to produce uniform particles across various chip sizes. Figure 3B plotted the particle size versus droplet size of PLGA at maximum throughput for three different PLGA concentrations (1%, 3%, and 10% w/v). This demonstrates the relationship between droplet size and particle size across varying concentrations, highlighting how different polymer concentrations affect particle size.

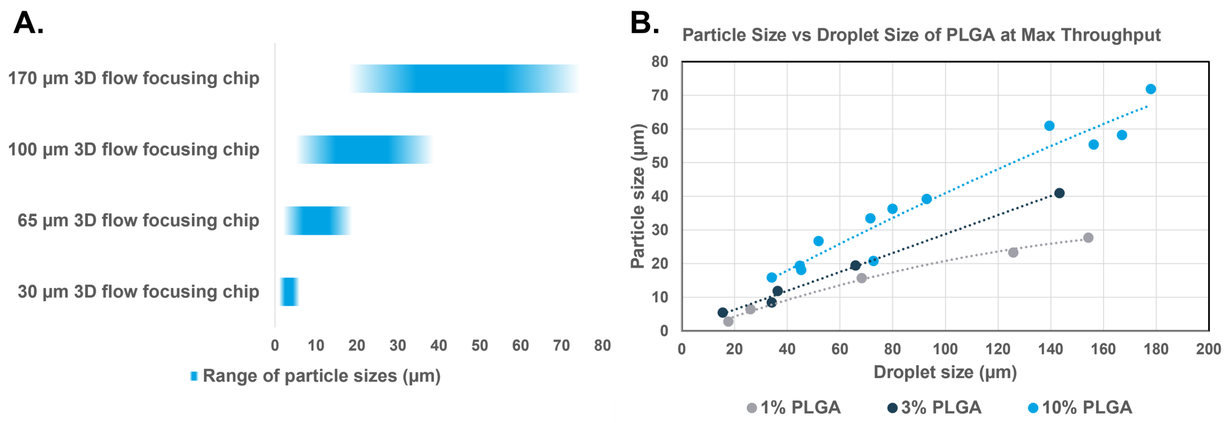

Figure 3. A) Range of PLGA particle sizes produced using different 3D flow focusing chips in the Dolomite Mitos system. The chart illustrates the particle size distribution for each chip size. B) particle size versus droplet size of PLGA at maximum throughput for three different PLGA concentrations (1%, 3%, and 10% w/v).

SEM imaging provided detailed visualization of the particle morphology, confirming the uniform particles produced at varied sizes (Figure 4). The relationship between chip size, flow conditions, polymer concentration, and resultant particle size was systematically analyzed, underscoring the system's capability to tailor particle specifications for specific therapeutic needs.

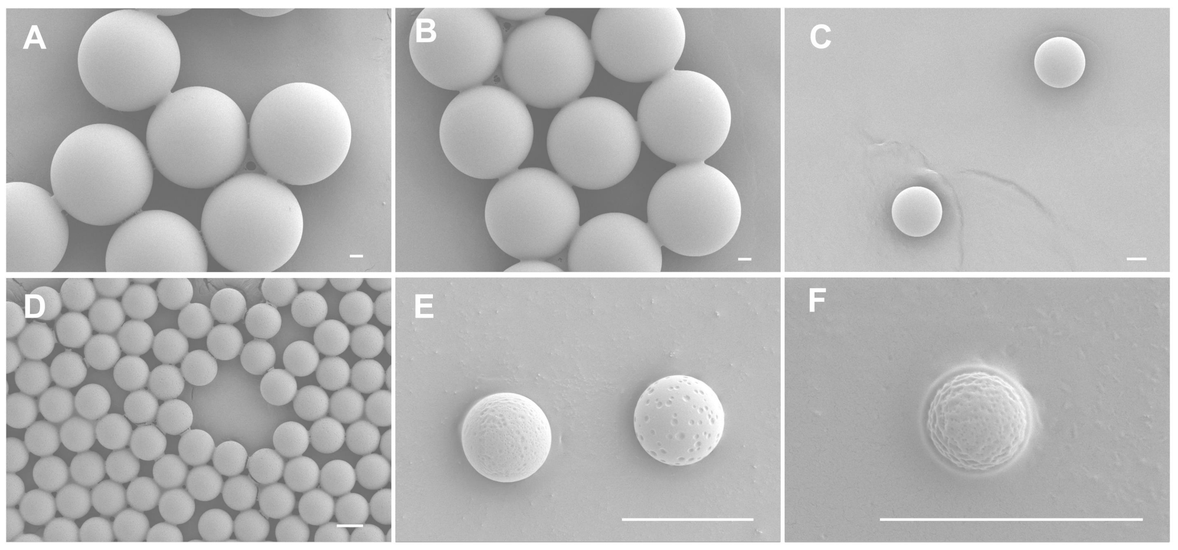

Figure 4. SEM images of PLGA particles produced using the Dolomite Mitos System, shown uniformly sized particles at different sizes and magnifications. Scale bar = 10 µm.

Biography

Mei Wu is an Applications Manager at Dolomite Microfluidics (Unchained Labs). She obtained her PhD from the University of Edinburgh. Her current research focuses on advancing microfluidic technology to improve the precision and efficacy of pharmaceutical applications.

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Learning Objective

- Identify the benefits of microfluidic tools like the Dolomite Mitos System for the synthesis of uniform microparticles.
- Analyze how particle size, distribution, and morphology, characterized by SEM, affect the functionality of drug delivery systems.
- Evaluate the scalability and technical adaptability of the Dolomite systems in pharmaceutical research and production settings.