ORT_21 - High-throughput Generation of Uniform Microspheres: A Versatile Platform for Numerous Applications

Waldemir de Castro Silveira[1]; Igor Hirle Aguiar[1].
[1]Trimatrix Applied

Introduction: This study presents a microfluidic method for the high-throughput production of uniform polystyrene (PS) microspheres, which have various applications in medical, biological, and industrial fields. These applications include spacers in liquid crystal displays, standard particles for particle size analyzers, microencapsulation, drug delivery, biodiagnostics, and combinatorial synthesis.

Objectives: The main objective of this research is to develop a scalable and reproducible microfluidic system that generates uniform droplets and transforms them into PS microspheres with precise control over size and morphology.

Methodology: The microfluidic system features a photocured 3D-printed microchannel device with a tee-structure design, which produces monodispersed droplets with diameters less than 50 µm. The droplets' diameter ranges from 35 to 52 µm, and the PS microspheres have diameters between 16.9 and 23.5 µm, exhibiting a reduction in size during the polymerization process.

Results: The system achieves a maximum droplet generation frequency of 2.8 x 10^4 Hz, leading to the production of approximately 270 mg of PS particles per hour. The generated PS microspheres possess excellent dispersibility, which is essential for their biological applications, such as microencapsulation and drug delivery.

Conclusion: The high-throughput, scalable, and reproducible nature of this method offers a versatile platform for numerous applications, including the production of micron-sized particles with uniform size and morphological characteristics. This study highlights the potential practical implementation of microfluidic particle preparation systems for mass producing uniform microspheres, expanding their applications in various industries. The precise control over size and morphology, combined with the high-throughput production rate, makes this technology a valuable tool for the production of PS microspheres with significant economic value.

Keywords: Microfluidic particle preparation; Uniform polystyrene microspheres; High-throughput production