

Review

Transforming Nanomaterial Synthesis through Advanced Microfluidic Approaches: A Review on Accessing Unrestricted Possibilities

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Abstract: The inception of microfluidic devices marks a confluence of diverse scientific domains, including physics, biology, chemistry, and fluid mechanics. These multidisciplinary roots have catalyzed the evolution of microfluidic devices, which serve as versatile platforms for various chemical and biological processes. Notably, microfluidic devices have garnered attention as efficient reactors, offering distinct benefits such as minimized spatial requirements for reactions, reduced equipment costs, and accelerated residence times. These advantages, among others, have ignited a compelling interest in harnessing microfluidic technology for the conception, refinement, and production of various nanomaterials and nanocomposites, pivotal within both industrial and medicinal sectors. This comprehensive exposition delves into multifaceted aspects of nanomaterial synthesis, underscoring the transformative role of microfluidic methodologies as a departure from conventional techniques. The discourse navigates through intricate considerations surrounding the preparation of nanomaterials, elucidating how the microfluidic paradigm has emerged as a promising alternative. This paper serves as an illuminating exploration of the juncture between microfluidic innovation and nanomaterial synthesis. It traverses the transformative potential of microfluidics in revolutionizing traditional approaches, heralding a new era of precision engineering for advanced materials with applications spanning industrial to medicinal domains.

Keywords: nanomaterials; synthesis processes; microfluidic process; cost-effective



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1. Introduction

Nanomaterials represent a fascinating class of substances sought after for their diverse practical applications. Defined by their size falling within the 1 to 100 nm range, these materials hold immense promise across various fields. Fabricating nanomaterials involves employing various methods tailored to their specific types and properties. The two primary approaches used for their development are the “top-down” and “bottom-up” methods, as illustrated in Figure 1 below [1]. In the bottom-up approach, materials are built atom by atom or molecule by molecule, ultimately forming nanoparticles (NPs). This process often begins at the atomic scale, where nucleation occurs, forming nanoscale structures.



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