Nanomaterial synthesis through microfluidic methods

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Abstract

Microfluidic technology represents an emerging promising solution for nanomaterials synthesis, ensuring tight control over reaction parameters, high reproducibility, efficient adjustable mixing, reduced reaction duration, and a safe operational environment. However, microreactors are still under development and facing challenges in their utilization and widespread adoption, and more in-depth research is needed before being translated to industrial sectors. In this regard, the research theme proposed for elaborating the present Ph.D. thesis aligns with the global trends concerning microfluidic technology development, expanding the knowledge in the field with new and innovative three-dimensional platform designs. In more detail, the research was focused on 4 main directions: (i) laser-based fabrication of 3D multilayered microfluidic assemblies made of transparent polymers for confining chemical reactions, (ii) operational testing of the designed 3D microfluidic platforms for high-yield magnetic core-shell nanoparticle synthesis, (iii) advanced physicochemical characterization of the produced nanomaterials, and (iv) qualitative demonstration of pesticide adsorption capacity of aerogel-based nanocomposites embedded with the magnetic nanoparticles synthesized on the custom-designed 3D microreactors. The successful accomplishment of the thesis aim, supported by the disseminated results, confirms the remarkable potential of designed 3D microfluidic platforms in precision nanoparticle production, emphasizing the suitability of the synthesized magnetite-based nanomaterials for further biomedical and environmental applications.