Continuous Flow Synthesis of Metallic Nanoparticles and Their Applications

Catherine Gomez

Laboratory of Genomic, Bioinformatic and Molecular Chemistry (EA 7528), Group of Molecular Chemistry, Conservatoire National des Arts et Métiers (Cnam), 2 rue Conté, 75003 Paris, France

E-Mail : catherine.gomez@lecnam.net

Abstract

Continuous flow chemistry is becoming increasingly popular, as it can be used to address a wide range of issues in terms of reproducibility, stability, safety and productivity, all of which are essential for many academic and industrial syntheses in organic and inorganic chemistry. In this context, our approach has focused on the development of continuous flow devices coupled with thermal [1], sonochemical [2] and microwave irradiation [3] methods. Indeed, the use of more efficient and eco-friendly synthesis pathways is currently a major challenge. The literature refers to several examples of how organic compounds of interest [4] can be synthesized using this methodology. The synthesis of inorganic compounds [5], which will be developed in greater details in this presentation, is also possible using these processes.

The methodology considered for accessing inorganic nanoparticles will highlight how the principles of green nanochemistry derived from Anastas and Warner's twelve principles could be applied, while managing the complexity of heterogeneous media. The efficiency of continuous flow coupled with greener activation methods will show how reagent quantities and reaction times can be optimized. It will also be important to consider productivity between the different devices, as well as the quality of the nano-objets obtained, so that they are pure, stable and homogeneous in size. Thanks to quality synthesis on a large scale, these nano-objets can be used in a variety of applications in electronics, catalysis and medicine (Radiotherapy, PDT, PTT) [6].

References

[1] G. Hallot, Y.S. Chan, F. Ménard, M. Port, C. Gomez Continuous Flow Synthesis of Bismuth Nanoparticles: A Well-Controlled Nano-Object Size Thanks to Successful Scaling-Up. *ACS Sustainable Chem. Eng.* **2025**, 13, 1431-1439. [2] C. Gomez, G. Hallot, A. Pastor, S. Laurent, E. Brun, C. Sicard-Roselli, M. Port Metallic Bismuth Nanoparticles: Towards a Robust, Productive and Ultrasound Assisted Synthesis from Batch to Flow-Continuous Chemistry. *Ultrason. Sonochem.* **2019**, *56*, 167-173. [3] G. Hallot, V. Cagan, S. Laurent, C. Gomez, M. Port A Greener Chemistry Process Using Microwaves in Continuous Flow to Synthesize Metallic Bismuth Nanoparticles. *ACS Sustain. Chem. Eng.* **2021**, *9*, 9177-9187. [4] (a) Z. Jaman, T.J.P. Sobreira, A. Mufti, C.R. Ferreira, R.G. Cooks, D.H. Thompson Rapid On-Demand Synthesis of Lomustine under Continuous Flow Conditions. *Org. Process Res. Dev.* **2019**, *23*, 334–341. (b) J. Britton, T.F. Jamison The assembly and use of continuous flow systems for chemical synthesis. *Nature Protocols* **2017**, *12*, 2423-2446. [5] C. Gomez, G. Hallot, M. Port Bismuth metallic nanoparticles in A.M. Grumezescu Inorganic frameworks as smart nanomedicines. Pharmaceutical *Nanotechnology Series*, Elsevier **2018**, 1-699. [6] C. Gomez, G. Hallot, S. Laurent, M. Port Medical Applications of Metallic Bismuth Nanoparticles. *Pharmaceutics* **2021**, *13*, 1793-1819.