LABORATOIRE DE GÉNIE CHIMIQUE
TOULOUSE • UMR 5503

POSTDOCTORAL POSITION

High-Throughput Continuous Automated Production of Noble Metal Nanoparticles Assisted By IA

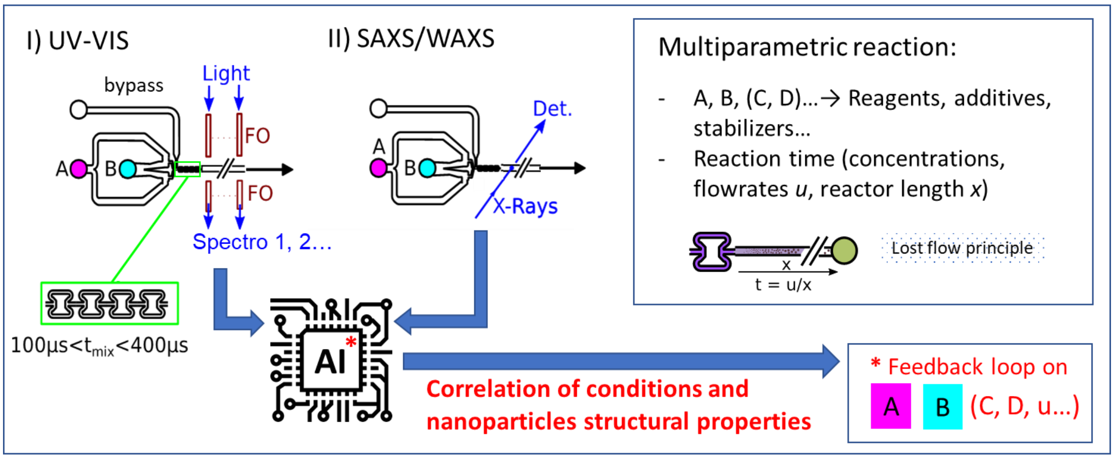
State of the art

Reactive precipitation processes are key technologies for the fast development of new nano-materials (metals, ceramics, (bio)polymers…). Well-controlled process intensification approaches, based on microfluidics, are being recently developed at the laboratory scale, favouring more efficient and environmentally friendly manufacturing conditions. Microfluidics allows for high throughput, and increased reproducibility and yield through larger surface-to-volume ratios, and sub-millisecond mixing times which allow decoupling particle nucleation and early growth stages from mixing, Indeed, these approaches permit keeping a strict control over nanoparticles morphology and size distributions, promoting monodispersity and homogeneous properties otherwise difficult when using standard macroscopic batch synthesis methods.

However, scaling up microfluidics toward industrial conditions becomes essential to pave a way for a new generation of faster industrial processes with less environmental impact. In this sense, the industrial necessity of an automated control on particle production processes passes through online, in situ reaction characterization, and through the implementation of control loops, assuring product quality under non-ideal process conditions (perturbations of reagent flows, temperature variations, etc). Equally, industrial production necessities compel to an increase of production volumes by either millifluidic approaches or microfluidics multiple system parallelization.

Objectives

The objective of this work is to set up a technologically challenging proof of concept, of a high-throughput microfluidic/millifluidic reactor platform, transposable to other laboratories, for the continuous production of noble metal nanoparticles. The reactor operation will be governed by feedback control loops over defined input variables toward desired nanoparticle properties. Nanoparticle syntheses will be coupled to UV-Vis and other spectrometric techniques (see schematics below) to interrogate the system and to acquire information regarding the state of reaction, which should eventually feed specific AI tools developed to improve the management of the experimental process.



Tasks

- Fabrication of the microfluidic systems in accordance to previously defined standards and setting up of micro-reactor platforms.
- Characterization of mixing efficiency and reactor performance as a function of non-symmetric reagent flow rates (Optical Microscopy, Fluorescence Microscopy, Raman confocal microscopy).
- Adaptation of reaction chemistry to the microfluidic environmental specifications.
- Definition of characteristic times of reaction and optimization of optical paths for UV-Vis probing
- Data analysis, including the creation of a spectral UV-Vis database linked to reaction conditions, electron microscopy nanoparticle characterization for population balance calculations, and application of AI tools to define feedback control loops on reaction parameters
- Articles and reports writing
- Managing the interactions among interdisciplinary skilled team members and also with external collaborations for IA implementations

POSTDOCTORAL POSITION

Your profile

We are seeking highly motivated candidates wishing to boost their scientific career on a technological and highly interdisciplinary front-line project, within a leading-edge laboratory holding both required facilities and a long track record of interdisciplinary expertise. Applicants presenting an experimentalist profile with a strong educational base in chemical physics (ideally in relation to chemistry and/or microfluidics) are particularly encouraged to submit a candidature. The postdoctoral researcher will fully proficiently develop and manufacture microfluidic/millifluidic devices coupled to spectroscopic detection techniques and will be responsible for coding for automated data acquisition, analysis, and database creation. In this regard, candidates with demonstrated experience in microfabrication techniques and microfluidics operation, chemical syntheses, the use of routine standard analytical techniques, and programming skills (python, Matlab) for data analysis will be particularly pursued. Full proficiency in the English language, oral and written is also required.

Framework

This postdoctoral offer, exploring process intensification through microfluidic approaches, is framed within the demonstrator 2FAST (Federation of Fluidic Autonomous labs to Speed-up material Tailoring) of the PEPR (Programmes et équipements prioritaires de recherche) project DIADEM, which is an ambitious project towards the acceleration of the design and production of more efficient and sustainable materials. The researcher will be part of an excellence network including 4 different laboratories on the national scale, namely ICMCB (UMR5026) and LOF (UMR5258) at Bordeaux, ISEC (CEA) at Marcoule, and LIONS (UMR 3685) at Paris.

Applications

The application must be in English and include a curriculum vitae, a letter of intent, and two recommendation letters or at least 2 persons to contact. The application documents must be sent as a single PDF file. Incomplete applications will not be considered for evaluation. Applications will be reviewed as they are received until the position is filled. For enquiries about the position and application submission, please email Dr. Isaac Rodriguez-Ruiz (isaac.rodriguez-ruiz@cnrs.fr), Dr Kevin Roger (kevin.roger@toulouse-inp.fr), Dr. Sébastien Teychené (sebastien.teychene@toulouse-inp.fr), Dr. Yannick Hallez (yannick.hallez@univ-tlse3.fr) and Dr. Martine Meireles (martine.meireles-masbernat@univ-tlse3.fr). Candidates defending their PhD before April 2023 are also welcome to apply for the position.

References:

- Roger, K. et al. (2022). Controlling nanoparticle formation from the onset of nucleation through a multi-step continuous flow approach. *Journal of Colloid and Interface Science*, *608*, 1750-1757.

- El Amri, N., et al. (2020). Polyvinylpyrrolidone (PVP) impurities drastically impact the outcome of nanoparticle syntheses. *Journal of Colloid and Interface Science*, *576*, 435-443.

- Gestraud, C., et al. (2020). Injection time controls the final morphology of nanocrystals during in situ-seeding synthesis of silver nanodisks. *CrystEngComm*, *22*(10), 1769-1778.

- Ramamoorthy, et al. (2020). The role of pre-nucleation clusters in the crystallization of gold nanoparticles. *Nanoscale*, *12*(30), 16173-16188.

- Rodríguez-Ruiz, I., et al. (2017). Innovative high-throughput SAXS methodologies based on photonic lab-on-a-chip sensors: Application to macromolecular studies. *Sensors*, *17*(6), 1266.

- Rodríguez-Ruiz, I. et al. (2016). Continuous sensing photonic lab-on-a-chip platform based on cross-linked enzyme crystals. *Analytical chemistry*, *88*(23), 11919-11923.

- Rodríguez-Ruiz, I., et al. (2015). Photonic lab-on-chip (PhLOC) for enzyme-catalyzed reactions in continuous flow. *Microfluidics and Nanofluidics*, *18*(5), 1277-1286.

Additional information:

Workplace: TOULOUSE

Type of contract: Fixed-term scientific contract

Contract duration: 12 to 18 months with a trial period of 3 months subject to evaluation.

Starting date: To start from February-March 2022, no later than May 2023

Full time job

Required education qualification: PhD

Desired experience: 1 to 4 years