Post- Doc position

Understanding plasma-liquid interactions during the formation of iron oxides: exploring the potential of liquid TEM

Duration of the contract: 12 months

Starting date: January 2023

Laboratoire des Sciences des Procédés et des Matériaux

Laboratoire Matériaux et Phénomènes Quantiques

Description of the topic

Iron-based nanomaterials formed by a process using plasma-liquid interactions (PLI) represent an interesting option for the treatment of inorganic arsenic polluted water polluted.

This project aims to move forwards in understanding the iron-based metallic nanostructures (NPs) formation when working with electric discharges generated in an aqueous solution of the metallic precursor.

We intend to use an analogy-based approach, between the phenomena/processes present in water radiolysis and the PLI process. More specifically, the project will focus on understanding the kinetic and thermodynamic effects that dictate the nucleation-growth of iron oxide particles by radiolysis. Liquid transmission electron microscopy (liquid TEM) is a technique of choice to address this challenge. This technique exploits the imaging and analysis (EDX / EELS) performances of TEM to study a thin liquid layer (< 500 nm) of controlled composition and temperature, which is confined between two silicon nitride membranes.

When the electron beam of a TEM interacts with a liquid sample, radiolysis processes produce molecular and radical species that alter the solution chemistry in the irradiated area. For example, aqueous electrons produced by radiolysis in water can reduce metal precursors and activate the nucleation and growth of metal NPs. Similarly, other products of radiolysis (hydroxyl radicals) can generate oxidizing reactions leading to the formation of metal oxides. It is worth noting that the concentration of radiolytic products depends on the electron dose flux, a parameter that can be precisely controlled in the TEM.

The work will thus be to capitalize on this dependence to control the driving force of NPs synthesis in situ, and thus to visualize directly, at the atomic scale, the effects of the growth rate on the size, shape, composition or structure of the NPs.

Activities

The activities to be carried out, essentially experimental, will be articulated around the objectives of the project, which leads to a methodological approach in two tasks:

1. Characterization of the synthesized iron-based particles: SEM/TEM/DRX/FTIR of particles already obtained with the PLI process ;
2. Understanding the particles nucleation by radiolysis - control of the size and structure of the obtained nanoparticles. The aim is to identify the physical and chemical mechanisms involved according to :
    a. local radiation conditions: dose, dose rate;
    b. the physical and chemical properties of the solution: conductivity, pH, composition, temperature ;
    c. effect of the presence of other compounds: radical scavengers / (e_{aq}^-) , functionalizing agents./(e_{aq}^-).

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Skills

The candidate (F/M) must hold a Ph.D. in a relevant experimental area of materials science: solid state physics/chemistry, synthesis, solution chemistry, materials and irradiation. He/she will be expected to show initiative and creativity, as well as the appropriate skills and knowledge necessary to achieve the project objectives.

The candidate (M/F) must have experience in electron microscopy techniques. Knowledge in liquid microscopy would be a considerable asset.

Working environment

The work will be done partially in the team « Microscopie Electronique Avancée et Nano-Structures (M*e*ANS) » of the Matériaux et Phénomènes Quantiques (MPQ) laboratory, and partially in the team "Procédés Plasma Polyphasiques pour l'Environnement - 3PE" of the Laboratoire des Sciences des Matériaux et des Procédés (LSPM). The work will be supervised by Damien Alloyeau, DR CNRS and Arlette Vega, IR CNRS.

This research project is funded by LABEX SEAM (Science and Engineering for Advanced Materials and devices). Monthly salary: 2250 to 3500 €, according to experience after PhD.

Additional information

The candidate must have a strong motivation for experimental work (obtaining, synthesizing and analyzing data) and strong organizational skills.

The application must include a detailed CV and a cover letter.

Application deadline: October 15, 2022

Laboratoire Matériaux et Phénomènes Quantiques

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Here are more information on the two groups at MPQ and LSPM.