Post-doctoral researcher - Controlled synthesis of gold/polymer nanocomposite films by multifrequency cold plasma at atmospheric pressure

Laboratory: PROMES (CNRS UPR 8521)
Workplace : Perpignan, France
Contract Period : 18 months
Expected date of employment : March 2024
Supervisor : Françoise Massines <francoise.massines@univ-perp.fr>

Missions
This post-doctoral fellowship will take place within the framework of the ANR PLASSEL project, the objective of which is the controlled synthesis of Au/polymer (plasmonic thin layers) and then Ni/polymer (magnetic thin layers) nanocomposite films by multi-frequency cold plasma at atmospheric pressure. This project aims to adress the need for safe by design processes to produce a wide variety of polymer- metal nanoparticles nanocomposite thin layers with controlled properties on large surfaces. The proposed solution, never explored before, consists of jointly using an aerosol of metal salts solubilized in a polymerizable solvent and a cold plasma at atmospheric pressure.

Following a first PhD thesis related to the project, a range of conditions enabling the obtention of gold/ polymer nanocomposites was determined. The nanoparticles and the matrix are formed and deposited using a dielectric barrier discharge (DBD) combining 2 frequencies (800 Hz and 50 kHz); 50 kHz to polymerize the solvent and reduce the salt to form the metal nanoparticles, and 800 Hz for the electrostatic force to transport the nanoparticles to the substrate. The obtained films are morphologically, chemically and optically characterized.

In the frequency range defined above, the DBDs are filamentary in the presence of the aerosol. In a first step, the post-doctoral fellow will have to extend the frequency range from 50kHz to radio frequency (13.56 MHz), which could help homogenizing the DBD and better control the properties of the deposited thin layer. He/she will also explore and analyze the effect of different chemical (nature and concentration of the metal salt) and electrical (intensity and modulation of applied voltages) parameters on the properties of the deposited nanocomposite films. For this, he/she will use optical and electrical characterizations of the plasma and of the obtained films. He/she may also be involved in the simulation of the optical properties of the nanocomposite films and their link with the morphological properties.

Secondly, he/she will extend the synthesis to other metals, such as nickel, by seeking to obtain metastable forms of metal nanoparticles that can lead to high added value applications in the field of magnetism.

Activities
Atmospheric pressure plasma synthesis of nanocomposite films
Optical and electrical characterization of plasmas
Morphological, chemical and optical characterization of thin films (AFM, SEM, optical absorption, spectroscopic ellipsometry)

Skills
The candidate holds a doctorate in physics or chemistry of thin layers or plasmas.
He/she must have good experience in the plasma process. Skills in the analysis of thin film characterization results will be a plus.

Be organized, autonomous, rigorous
Be proactive.
Know how to write reports and scientific articles.
Know how to communicate results in national conferences and meetings and in international conferences.

Work context
The PROMES laboratory is a CNRS Unit (UPR 8521) attached to the Institute of Engineering and Systems Sciences (INSIS) under agreement with the University of Perpignan via Domitia (UPVD). The laboratory brings together around 150 people from the CNRS and the UPVD around a unifying subject, solar energy and its use as a source of energy and high temperatures.

The researcher will be assigned to the Perpignan site, and be part of the Materials for Energy and Space group, which gathers more than thirty researchers involved in the development and understanding of the materials for the future.

The post is funded by the ANR project PLASSEL (Multi-frequency cold PLASma at atmospheric pressure and aerosol of metallic SELs for an innovative, safe by design process for deposition, in one step, of thin plasmonic and magnetic nanocomposite layers), which involves researchers from 4 French laboratories: PROMES, LAPLACE (Toulouse), LSPM and ITODYS (Paris). The consortium brings together modelers and experimenters specializing in the growth of NPs in a plasma, discharges at atmospheric pressure and associated processes as well as specialists in the implementation and characterization of nanocomposites and their plasmonic and magnetic properties. .

Constraints and risks
The position is located in a sector falling under the protection of scientific and technical potential (PPST), and therefore requires, in accordance with regulations, that the arrival of the researcher be authorized by the competent authority of the MESR.

Additional information and application
Interested applicants should send a CV and a motivation letter to F. Massines francoise.massines@univ-perp.fr

References
[1] https://anr-plassel.fr/
[2] E. Nadal et al., A new approach for synthesizing plasmonic polymer nanocomposite thin films by combining a gold salt aerosol and an atmospheric pressure low-temperature plasma, Nanotechnology 32 175601 (2021), https://doi.org/10.1088/1361-6528/abdd60
[3] A. Perdrau et al. Synthesis of Gold NPs-Containing Thin Films from Metal Salt Injection in Ar or Ar–NH3 DBDs. Plasma Chem Plasma Process (2023). https://doi.org/10.1007/s11090-023-10400-4