PhD (M/F) in Polymer Chemistry (CP2M/IMP) with financial support from Graduate+ LPMS

In the frame of the Graduate+ initiative: Lyon Polymer Materials Science (LPMS) of the University Lyon 1 (France), we offer a **PhD fellowship in Chemistry** for a period of three years, starting on **April 2024**.

The PhD student will be co-supervised by Dr. Elodie Bourgeat-Lami (DR CNRS, Laboratory of Catalysis, Polymerization, Processes and Materials (CP2M, UMR 5128)) and Prof. Emmanuel Beyou (laboratory Ingénierie des Matériaux Polymères (IMP, UMR 5223)).

The online application period will begin in January 2024, and an audition will be held in February 2024 for the final selection of candidates.

Title: Graphene-armored polymer latexes: from colloidal design to conductive film properties

Context and objectives

In the past decades, there has been increasing interest in using colloidal particles in water (i.e., polymer latexes) to create nanocomposites [1]. Numerous examples of hybrid polymer-organic or polymer-inorganic nanomaterials have been demonstrated, where the polymeric phase is combined with metal oxides, semiconductors, as well as various types of one- or two-dimensional materials such as cellulose nanocrystals (CNCs) [2], carbon nanotubes (CNTs) [3] or clay minerals [4]. Among the various types of particles, those composed of a polymer core surrounded by a shell of conductive graphenic fillers, have attracted particular attention [5, 6]. Indeed, such armored morphology guarantees electrical percolation of the conductive filler upon film formation leading to high conductivity values for very low filler volume fractions. In an ideal situation, the conductive particles can also act as Pickering stabilizers, dispensing with the use of organic surfactants [7]. Most current methods for forming graphene-based colloidal nanocomposites rely on the use of GO [5, 8] as the latter can be easily dispersed in water and functionalized to promote its interaction with the polymer matrix. However, GO is electrically insulating and thermally unstable. Consequently, at least partial reduction is required to restore electrical conductivity, leaving behind some structural defects, affecting therefore the electrical and thermal properties.

The main goal of this PhD thesis is to synthesize **graphene-based colloidal nanocomposites with armored morphology to produce conductive film materials**. Exfoliated graphene sheets stabilized with functional molecular or colloidal polyelectrolytes, will be incorporated into polymer latexes to form armored particles, resulting after casting in film materials with controlled microstructure and consequently both high electrical and mechanical properties.

Scientific program

The project will be divided into three main tasks:

T1. Preparation of stable aqueous dispersions of functionalized graphene nanosheets.
T2. Synthesis of graphene- and graphene/CNC-based colloidal nanocomposites by emulsion polymerization.
T3. Film formation, microstructure and properties.

Required skills for the PhD candidate

We are looking for a **highly motivated candidate** with a strong scientific background in synthesis and characterization of polymer materials with knowledge in (physico)chemical analyses (NMR, FTIR, SEC, DLS). The ideal candidate has previous experience in colloid and materials science. He/she should have a Master's degree in chemistry, physical chemistry, materials science or nanoscience, with a background in polymer chemistry.

The candidate should be autonomous and curious, and able to share his/her results. An excellent level of English would be an advantage.

Scientific environment

This project is an interdisciplinary research project. The PhD student will share his/her time between CP2M and IMP and will benefit from a highly multidisciplinary and stimulating scientific environment that includes polymer synthesis & characterization, structural analysis of materials, mechanical and electrical characterizations. The CP2M and IMP laboratories are located on the campus "La Doua" of **Université Claude Bernard Lyon 1**, in the north of the city of **Lyon (France)**, easily accessible by public transportation. They are geographically close to each other, which will facilitate day-to-day collaboration as the candidate will be able to come and go and organize his/her work between the two laboratories according to his/her needs.

Application

Interested candidates should send their application by e-mail to Elodie Bourgeat-Lami (elodie.bourgeat-lami@univ-lyon1.fr) and Emmanuel Beyou (beyou@univ-lyon1.fr) as a single PDF file including:

- A cover letter explaining background and motivation
- A CV
- A copy of the transcript for the 2nd year Master degree
- One or two letters of recommendation (or failing that, contact details of previous supervisors).

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[2] E. Limousin, N. Ballard, J. M. Asua, *Polym. Chem.* **2019**, 10, 1823.
[3] C. Dionigi, P. Stoliar, G. Ruani, S. D. Quiroga, M. Facchini, F. Biscarini, *J. Mater. Chem.* **2007**, 17, 3681.
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[7] S. C. Thickett, P. B. Zetterlund, *ACS Macro Lett.* **2013**, 2, 630.
[8] Y. Fadil, S. C. Thickett, V. Agarwal, P. B. Zetterlund, *Prog. Polym. Sci.* **2022**, 125, 101476.