PhD fellowship

Dynamic control in hybrid plasmonic nanopores: road to next generation multiplexed single molecule detection

The Institut Fresnel is a research state laboratory based in Marseille / France, devoted to research and higher education with affiliation to both CNRS and Aix Marseille University. Institut Fresnel is seeking to recruit talented, enthusiastic young scientists who are highly motivated to boost their research career in the areas of nanosciences, biosensing, and biotechnologies.

Motivation

The successful candidate will be part of an emerging project carried out at the Institut Fresnel under the supervision of Jérome Wenger with the funding of Marie Skłodowska-Curie Doctoral Networks HORIZON-MSCA-DN-2021 project called DYNAMO.

DYNAMO is designed as an innovative and pioneering training network, with the unique vision of developing the next-generation hybrid nanopore technology exploiting DNA nanostructures integrated with multifunctional solid-state platforms, by:

- Bringing together a unique team of 6 world-leading academic groups, at the forefront of nanoscience and single molecule sensing and manipulation, and 1 high tech company, to translate the innovations into real-world applications;
- Training 10 Junior Researchers (JR) on a unique mix of experimental and computational skills at the physics/chemistry/biotechnology interface;
- Enabling technological advances through the combination of enhanced optical spectroscopies, plasmonics and DNA nanotechnology. This will lead to the development of nanopore technologies with unprecedented functionality and single molecule control;
- Reaching single molecule capturing and tweezing functionality in solid-state nanopore in a way that has not been possible before. This will pave the way to fascinating new discoveries into the fundamental structures of biomolecules and the interaction forces among them.

Research / Job description

Jerome Wenger's group has acquired a wide expertise in the nanoscale control of light fields in plasmonic nanostructures and its application to enhance fluorescence spectroscopy applications. For our next project within the DYNAMO consortium, we will focus on plasmonic trapping and enhanced UV label-free single protein detection with plasmonic nanopores.

Objectives: The aim of this project will be to exploit the intrinsic UV autofluorescence of proteins (due to their natural aromatic aminoacids) to achieve single molecule detection in a label-free manner. The JR will develop a nanopore platform able to trap single entities by means of magnetic force and/or in combination with plasmonic nano-optical trapping using the red laser. The spectroscopy approach will be combined with dedicated aluminium nanopores to (i) enhance the deep-UV autofluorescence signal, (ii) monitor translocation and (iii) screen the background. To investigate possible conformational changes of the protein, the JR will learn how to combine the deep-UV approach with a conventional fluorescence labelling and detection using fluorescent dyes in the red spectral range. This multimodal approach will bring additional information without impairing the UV detection.

Expected Results: Controlled single protein translocation through the nanopore detected label-free in the deep-UV and confirmed by red fluorescent dye signal. Influence of the UV laser on the protein conformation and potential structural damages. Role of energy transfer between the dyes. Demonstration of plasmonic trapping at the single protein level.

Planned secondments: For the magneto-plasmonic trapping the JR will visit CIC GUNE for 2 months during year 1; For the fluorescence sensing in nanopore the JR will visit TU DELFT for 2 months during year 2; for deep-UV SERS spectroscopy the JR will visit BERLIN University for 3 months in year 3.

Opportunities for JRs when joining DYNAMO

- Participate in a highly committed network of academic and industrial leaders in the field of nanopore technology, single molecule spectroscopies and advanced nanostructures design and fabrication.
- Participate in a worldwide unique training programme, comprising individual research projects, interactive and hands-on courses, workshops and secondments covering the entire route to application of material sciences:
- In-depth knowledge on the potential and limitations of state-of-the-art nanopore technologies.
- In-depth knowledge on single molecule spectroscopies and single molecule electrical measurements.
- Training in intellectual property, business models, and regulatory approval pathways.
- Personalised training with room for development of personal and transferable skills (leadership, analytical, communication, interpersonal, free thinker mindset, creativity).
- Initiate network-wide events, such as workshops and symposia.
- Prepare for excellent performance in academia, industrial R&D, project management, consultancy and beyond.

Required qualifications – Eligibility

To apply for a PhD fellowship, candidates must hold an internationally-recognized Master-equivalent degree in physics, nanosciences or engineering.

Experience in experimental and/or theoretical research on nano-optics and/or biophotonics will be highly appreciated, but is not mandatory.

No restrictions of citizenship apply to the PhD fellowship.

Terms of employment – PhD fellowship

The position is intended as full-time (38 hrs / week, 12 months / year) appointment under CNRS contract. The fellowships are offered for periods up to three years.

The selected PhD student will work under close supervision of Jerome Wenger and benefit from direct mentorship. He/She will also benefit from several symposia and courses specially developed for them within the DYNAMO network (6 weeks planned over the duration of the PhD program).

A PhD degree from Aix Marseille University will be granted after successful completion of the PhD research.

The employment is to start as soon as possible and on February 1st 2023 at the latest.

Application procedure

Suitable candidates are requested to submit:

- a Curriculum Vitae
- a presentation letter with declaration of interests and a description of your past achievements (max. 1 page)
- contact email of two potential references
- a scanned copy of your university academic transcripts in English
- a scanned copy of the Master degree, if available at the time of application
- a scanned copy of standardized English test results (TOEFL, TOEIC,…) if available

Applications should be submitted by email to jerome.wenger@fresnel.fr.

Selection is based on merit and potential, measured in terms of the academic record and personal achievements. Proactivity, participation in community activities, and capacity for team-work are also taken into account.

The call will remain open until the position is filled.

Web Links

www.jeromewenger.com www.fresnel.fr/mosaic