ENS – IISER Network / BIOSANTEXC Project

Internship Proposal Form
France to India

(Discipline/Field name)

Materials Science/ Biodegradation of Nanomaterials

Internship title: Biodegradation of Nanomaterials: Effect of Chemical Functionalization

Keywords related with the subject (minimum 3): biodegradation, nanomaterials, enzymes, immune cells

Name of the IISER: IISER Thiruvananthapuram

Name of the laboratory(ies): Biomaterials Lab

Name of the internship supervisor(s): Dr. Rajendra Kurapati

Email(s): rkurapati@iisertvm.ac.in

Prerequisites for the internship: Bachelor or Master level in Chemistry or biology, Physical Sciences
Requested level:

Foreseen internship dates:

Internship type (refer to page 1):
× 3–6-month internship ☐ Research stays ☐ 6+6 months internship

For 3 to 6 months internships, please indicate the desired duration: 6 months

For 6+6 months internships, please also fill in:

- **Name of the internship co-supervisor:**
- **Name of the co-supervisor's laboratory/entity:**
- **Email of the co-supervisor:**

Internship proposal (description and expected training outcomes / half page min, 1 page max):

The discovery of graphene has led to the exploration of a large number of 2D inorganic materials, such as transition dichalcogenides, elemental layered materials (Xenes), transition metal carbides, nitrides and carbonitrides (MXenes). Recently, MXenes (e.g., $Ti_3C_2T_x$) have displayed immense potential for biomedical applications because of their high hydrophilicity (aqueous dispersibility) and surface reactivity of terminating groups to functionalize with bioactive molecules for therapeutic and diagnostic purposes. Photothermal therapies (PTT), drug delivery systems, cancer theranostics, and wearable medical devices, including antimicrobial coatings, have been developed based on MXenes. MXenes seem better than other 2D materials for biomedical applications concerning the high photothermal-conversion ability, surface reactivity, and water dispersibility.
The biodegradability of nanomaterials plays an important role in the clinical translation of their biomedical applications. In recent years, the use of two-dimensional transition metal carbides and nitrides known as MXenes (e.g., Ti_3C_2) has increased in many biological applications including drug delivery, photothermal therapy, tissue engineering, etc., due to their unique structural and chemical properties. However, MXenes interactions with the immune cells and possible biodegradability by peroxidase enzyme is poorly understood including protein corona formation around MXenes. Therefore, the proposed work will examine the effect of surface functionalization and protein corona formation on the biodegradability of MXenes using recombinant human peroxidases.

Ref:

1. K. Swetha, S. Sudeshna, F.A.L.S. Silva, F.C. Silva, B. Freitas, J.A.C. Incorvia, J.R. Fernandes, A. Jayaraj, S. Banerjee, N. Sadananda Singh, F.D. Magalhães, A.M. Pinto, ***R. Kurapati****, Biodegradability of Partially Reduced Nanographene Oxide by Human, Plant and Microbial Enzymes: Impact of Magnetic Nanoparticles, ***Carbon*** (2024) 119486.

2. K. Swetha, A. Camisasca, M. Bartkowski, A. Garhwal, A. Aravind, P. Gnanadhas, S. Giordani, ***R. Kurapati*,*** Biodegradability of Carbon Nano-Onions by Human Myeloperoxidase and Photo-Fenton Process, ***ChemNanoMat*** 10(6) (2024) e202300630 (Front Cover).

3. ***R. Kurapati***, S.P. Mukherjee, C. Martín, G. Bepete, E. Vázquez, A. Pénicaud, B. Fadeel, A. Bianco, Degradation of Single-Layer and Few-Layer Graphene by Neutrophil Myeloperoxidase, ***Angewandte Chemie International Edition*** 57(36) (2018) 11722-11727.