PhD position at CERMAV-CNRS, Univ. Grenoble Alpes, France

Project title: Electrospinning Light-Harvesting Polysaccharides: Towards Sunlight-Driven Smart Green Nanomaterials

Period: October 2019 – September 2022 (36 months)

Laboratory: Centre de Recherche sur les Macromolécules Végétales (CERMAV) - the French National Center for Scientific Research (CNRS), affiliated with Université Grenoble Alpes, Grenoble, France

Direction: Dr. Issei Otsuka (Permanent researcher of the CNRS)

Collaborator: Prof. Christopher J. Barrett (McGill University, Montreal, Canada)

Funding Agency: The French Ministry of Higher Education, Research & Innovation / France-Canada Research Fund New Scientific Collaboration Support Program

Description of the project:

This PhD thesis project aims to fabricate light-harvesting smart nanofibers consisting of natural polysaccharides and photochromic molecules using electrospinning technique. The project will be conducted by an international collaboration between I. Otsuka (CERMAV-CNRS, Univ. Grenoble Alpes) having expertise in electrospinning and poly-/oligosaccahride-based polymers, and C. J. Barrett (McGill University) having expertise in polymer materials and optical characterization.

There are continued challenges for the effective utilization of biomass toward functional materials and reduction of environmental burdens. Polysaccharides are, among other natural resources, one of the most abundant raw materials derived from biomass and renewable resources from forestry. The spotlight has been on not only their potential as alternatives for petrochemicals but also their biocompatible, biodegradable, and bioactive nature. Besides, stimuli-responsive polymers have been intensively studied since the behavior of these polymers can be controlled by simply changing their surrounding media. Among a variety of stimuli-responsive polymers, photo-responsive polymers have recently attracted much attention since the stimulus (light) can be localized in time and space and it can also be triggered from outside the system. Because of a large scientific gap between glyco-science and photo-science, these research fields have never overlapped deeply so far. Recently, Barrett's group reported that natural silk fibroin modified with azobenzene derivatives provides potential applications as soft tunable materials for dynamic cell guidance and microfluidics derived from their photo-responsive softening nature (*Soft Matter*, **2017**, *13*, 2903). This study suggested great potential of photo-responsive natural fibers for biomedical applications. Polysaccharides, represented by cellulose, are typical natural fibers, and thus they are the natural materials of great interest to be functionalized with photo-active compounds. Nevertheless, only few attempts have been made on the modification of polysaccharides with photo-responsive compounds and their physical and mechanical properties as fibrils have yet to be clarified. Recently, Otsuka's group reported the simple fabrication of cellulose nanofibers via direct electrospinning of dissolved cellulose solutions (*Cellulose*, **2017**, *24*, 3281). Electrospinning is a simple and versatile method that uses strong electric fields to draw polymer solutions or melts for the production of continuous fibers with nano/micro scale diameters. Nanofibers and nonwovens produced by electrospinning of functional polymers have attracted ever increased attention for their diverse potential in technical and biomedical applications such as functional textiles, filtration membranes, tissue engineering scaffolds, wound healing, drug delivery, *etc*.

From this background, this project focuses on 1) modification of polysaccharides with photochromic molecules, 2) electrospinning of the photo-responsive polysaccharides to fabricate nanofibers and their nonwovens, and 3) characterizing their physical and mechanical properties changes in response to light irradiation for potential applications *e.g.* self-healing fibers and artificial muscles.

Keywords: photoactuators, polysaccharide, electrospinning, artificial muscles, self-healing materials

Background and skills expected: The candidate must have a solid background in polymer chemistry (synthesis and basic physicochemical characterizations such as NMR, IR, UV-vis, SEC, XRD, *etc.*). Experience of electrospinning is preferred but not necessary. The candidate will be implicated in the collaboration project with Canadian research group (English ability required).

Application to: Issei OTSUKA (issei.otsuka@cermav.cnrs.fr) with 1) motivation letter showing clearly the aspects of your background, 2) CV, 3) transcripts of academic records (undergraduate and master), and 4) letters of recommendation or contact details for potential referees **no later than August 31, 2019**.