SUSTAINABLE AND BIO-FUNCTIONAL MATERIALS DERIVED FROM BACTERIAL PROTEIN

Dr. Noémie-Manuelle Dorval COURCHESNE
Department of Chemical Engineering
McGill University

ABSTRACT

Protein-based materials represent sustainable and easily customizable alternatives to conventional synthetic polymers. With their biocompatibility, bioactivity and genetic tunability, proteins can be customized for a range of applications. Specifically, protein materials that self-assemble into macromolecular structures and can be produced at large scale are of interest for deployment into wearable devices, tissue scaffolds, and alternatives for commodity materials like plastics, textiles and electronics. Curli fibers produced by Escherichia coli bacteria represent a very promising protein scaffold due to their unique physicochemical properties. Once secreted by bacteria cells, CsgA subunits, the self-assembling repeats of curli fibers, form fibrous structures that can further aggregate and gel into macroscopic materials. Among other functionalities, we have genetically encoded in CsgA the ability to fluoresce, to conduct charges, and to nucleate mineral particles.

In this talk, I will describe advances from our group to engineer curli fibers and confer them with properties relevant for biosensing devices, wearable, and plastic-like (“aquaplastic”) materials. First, I will present methods that we have developed to express and isolate bacterial fibers extracellularly secreted from E. coli cells, and I will show examples of materials (thin films, hydrogels, aerogels, coatings) that we have fabricated with these nanofibers. Then, I will focus on specific applications and proof-of-concept functional devices that we have fabricated. We will discuss bio-functionalized pH-sensing textiles, living adaptive wearable devices, curli-based bioplastics, and protein fibers – polymer composites for conductive biocompatible electrodes. Such devices bring us closer to a bio-based circular economy, and enable novel functions that can only be achieved by biological materials.