Faculty of Engineering and Applied Science
Chemical Engineering Seminar Series

Sustainable Nanomaterials from Cellulose & Protein: Emerging Building Blocks for Functional Applications

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Thursday, January 26, 2022, 2:30pm

Dupuis Hall, Room 215

The development of high-performance sustainable materials as a practical replacement for non-renewable products represents one of the most significant challenges of the 21st century. Luckily, interest in sustainable materials (and regulation concerning the use of non-sustainable materials) is rapidly growing, paving the way for fundamental research and development in areas spanning the biomedical sector, packaging, energy storage devices, construction, and coatings. To this end, my primary research interests surround the rational design and assembly of nanomaterial 'building blocks' based on cellulose and proteins – two of the most abundant natural polymers on Earth.

In this seminar, I will discuss some of my past research and future directions focusing on the use of cellulose nanocrystals (CNCs) and protein nanofibers (PNFs) in the bottom-up fabrication of materials such as hydrogels, aerogels, emulsions, and films for a variety of applications. An emphasis is placed on understanding key structure-function relationships between individual building blocks and fabricated materials therein. In particular, the ability to leverage intrinsic CNC material properties such as mechanical strength, shape anisotropy, and chemical functionality for the development of hydrogel scaffolds is highlighted. In addition, the use of common proteins such as lysozyme and bovine serum albumin for the fabrication of PNFs are discussed in relation to kinetics of self-assembly, fiber morphology, and surface charge. The incorporation of both CNCs and PNFs into composite materials are covered, demonstrating synergistic improvements in material properties such as mechanical strength, adhesive potential, and structural ordering. Taken together, the design and engineering of sustainable materials such as CNCs and PNFs represents a significant milestone towards a collective greener future.