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Expertise of the Supramolecular Nanoscale Assembly Group (SNAG) at the National Institute for Nanotechnology (NINT) and the University of Alberta (UofA)

The supramolecular nanoscale assembly group (SNAG) that I lead at the National Institute for Nanotechnology in Edmonton, Canada, is a multidisciplinary group of scientists, engineers and technical staff dedicated to understanding the underlying concepts of molecular recognition, self-assembly and self-organization processes, and utilizing this knowledge to address significant challenges primarily in the health and medical technologies, energy and environment, and ICT sectors.

The mission of the SNAG is to: (a) harness the chemical/physical properties and architecture of matter from the ground up through supramolecular synthesis, self-assembly and self-organization, (b) develop new technology platforms to address significant public health problems, meet current technological challenges, and stimulate the Canadian science and economy through the generation of a knowledge base in supramolecular sciences and engineering, and nanomedicine, (c) train highly qualified graduate students, postdoctoral associates and technical staff in the areas of molecular nanotechnology, functional materials, nanomedicine, biomedical engineering, drug discovery and targeted delivery.

Over the next three-years we will focus on 5 key inter-related areas: (a) develop rosette nanotubes (RNTs) as an adaptable drug display/delivery platform, in particular for cancer, lung inflammation, and bone therapy; (b) develop RNT-based biomaterials to maximize nanomedical device integration with the human body; (c) develop new synthetic strategies to generate conducting RNT nanowires; (d) expand the potential of DNA nanotechnology using RNTs as building blocks; (e) investigate the origin of supramolecular chirality generated from achiral self-assembling molecules.

In the context of these investigations, we will also explore the fundamentals of self-assembly and self-organization processes, continue to advance the design of materials with predefined dimensions and physical properties, and explore commercialization opportunities in the nanomedical device arena.
More specifically, our group designs and develops novel materials and processes for nanotechnology, microelectronics, catalysis, car industry, food packaging, and medicine, nanocrystalline cellulose (NCC) composites, functional thin films, sol-gel materials, nanostructured and nanoporous inorganic and organic-inorganic hybrid materials, polymer and biopolymer nanocomposites.

We have recently initiated a new project, which deals with finding innovative applications for nanocrystalline cellulose (NCC) as a bio based reinforcement for cellulosic polymers and plastics. We have established, optimized, and scaled up a procedure for isolating NCC from microcrystalline cellulose. The physical properties of NCC including high specific surface area, aspect ratio, tensile strength, and elastic modulus in addition to their unique bulk, surface and colloidal properties creates endless opportunities to develop new materials. High performance nanocomposites, paint/coating, cosmetics, medical/pharmaceutical applications and functional materials are some of the examples of our research interests.

The derived NCC may be used as-is or surface-modified with graft polymers, bioactive molecules, or metal oxides such as SiO2, TiO2, Al2O3, ZrO, CeO2 in order to generate different surface properties. Those modified NCC may be applied in coating formulation for treating wood surface resulting in synergistic useful properties such as scratch resistance, hardness, impact resistance, UV resistance, antimicrobial, fire barrier. Our group is also able to formulate polymer nanocomposites or bio-derived polymer nanocomposites involving NCC, clay nanoparticles or metal oxide nanoparticles as reinforcements using a solution or a melt blending process and evaluate their thermal, mechanical, barrier and rheological properties.

Our strategies give rise to nanomaterials with a broad spectrum of properties (catalytic, proton conducting, electronic, magnetic and optical properties). Therefore, cellulose nanocomposite materials with a broad spectrum of useful properties could be generated.

We are also well equipped for a wide range of synthesis and characterization techniques available both in our lab and as part of NINT/Chemistry department facilities. The instrumentation capability includes examining material composition, imaging by microscopy, and nanonofabrication. Our group has a number of researchers whose expertise lie in microscopy techniques (AFM, SEM, TEM, STM, SPM, IFM, SAED, EDX), spectroscopy techniques (e.g. Raman/SERS imaging, micro-FT-IR imaging, high filed NMR, fluorescence), thermal analysis (TGA, DSC), light scattering (SLS, DLS); X-ray analysis (SAXS, WAXS, XRD), gas physisorption (N2, Ar) for surface area, porosity, pore size and pore size distribution evaluation, mechanical properties characterization, chromatography, mass spectrometry, XPS, AES.

The details of specific research projects from our group and relevant literature can be made available upon request.