PhD Graduate Student Announcement in
“High-performance Tailored Bio-based Food Packaging”
at the Department of Forest Biomaterials, North Carolina State University
under the direction of Professor Nathalie Lavoine

Project Description
An increase in the global population is commensurate with increased waste, a major portion of which includes disposable packaging such as bottles, boxes and foils whose end-of-life cycle ends up polluting our rural and urban landscapes. The contribution of packaging material to the entire environmental footprint in the food value chain is estimated to be up to 45% depending on type of food and packaging materials [1]. Despite global packaging needs, overconsumption of petroleum resources and increasingly stringent environmental legislation for waste management demand the development of more sustainable and environmentally compliant packaging solutions.

We can consider traditional materials used in food packaging such as glass, metals (e.g. aluminum foils and laminates), paper and paperboard, and plastics. Beverage packages, for example, often combine several materials to exploit each material's functional or aesthetic properties. Due to the low cost of plastic materials and functional advantages such as thermosealability, microwavability and optical properties, the use of plastics in packaging continues to increase. However, the use of plastics also contributes to serious environmental concerns, and their variable permeability to light, gases, vapors and low molecular weight molecules are severe disadvantages for food preservation [2]. With growing consumers’ demand for higher-quality products, and changes in the profile of the industry caused by globalization, innovations in food packaging systems in terms of enhanced food safety, improved food quality and lower environmental impacts are required.

Over the past two decades, the valorization and conversion of low-cost lignocellulosic biomass into high value-added applications has gained attention. The extraction of cellulose nanomaterials (CNMs) in particular is creating a revolution in biobased materials owing to their high aspect ratio, high crystallinity, low density, large surface area, high strength-to-weight ratio and transparency [4]; properties which are suitable for diverse industrial applications such as packaging [5], cosmetics [6], automotive [7] and electronics [8].

CNMs have been used as functional coating of different plastic and fiber-based substrates for packaging applications [9,10]. Although significant improvements in barrier and mechanical properties of the coated-substrates have been reported, several key challenges such as high viscosity-to-solid content ratio and high moisture sensitivity remain, restricting their direct industrial application [9].

The main objective of this PhD project is to develop high-performance bio-based food packaging that are composed of cellulose nanomaterials and bio-sourced polymers, with enhanced barrier and mechanical properties, as a replacement of flexible packaging.

Several strategies will be considered for designing flexible thermosealable and microwavable nanocomposites. A specific focus is on sourcing wood biopolymers such as cellulose, lignin, and tannins. The heat and mass transfer properties of the designed materials will be intensely investigated across the length-scale by combining advanced techniques such nuclear magnetic resonance (NMR), positron annihilation lifetime spectroscopy (PALS), or fluorescence recovery after photobleaching (FRAP).

Graduate Research Assistantship Duration and Information.
3 years, including $23,000 per academic year stipend, in-state /or out-of-state tuition remission fees, and health insurance coverage.

The assistantship is subject to the Graduate Research Terms and Conditions for Appointment. The assistantship is renewable depending on the satisfactory performance of the graduate student. As part of the assistantship, the student is expected to help with undergraduate laboratory exercises for one semester. More information on the graduate school and application process can be found here: https://grad.ncsu.edu/
Location.
With more than 34,000 students and 7,000 faculty and staff, North Carolina State University is a comprehensive and world class university known for its leadership in education, research, and extension and globally recognized for its science, technology, engineering, and mathematics leadership. NC State students, faculty and staff are focused and of the highest competencies in each of the missions of the University. As one of the leading land-grant institutions in the nation, NC State is committed to playing an active and vital role in improving the quality of life for the citizens of North Carolina, the nation, and the world.

The Department of Forest Biomaterials is part of NCSU College of Natural Resources and offers degrees in Forest Biomaterials, Paper Science and Engineering, and Sustainable Materials and Technology. The Department’s research involves scientific and engineering innovation applied to a wide array of new forest-based materials and energy sources and novel manufacturing process. More information: http://cnr.ncsu.edu/fb.

Qualifications.
Level. MSc degree in materials science, materials chemistry, polymer engineering, chemical engineering, (or equivalent degree).
Experience. The candidate has (i) worked on bio-based polymers, more especially with cellulose; (ii) has knowledge in polymer science and materials characterization techniques (especially to assess the materials' mechanical and thermal properties); (iii) has experience of undertaking project research; (iv) has project management skills. Skillset in modeling and/or knowledge in pulp and paper science and engineering is a plus. Experience in some of the used methodologies; NMR, PALS or FRAP; is an advantage.

Competencies. The candidate must be enthusiastic and self-motivated. The candidate must be able to (i) work independently as well as in a team, (ii) demonstrate good English speaking and writing communication skills, (iii) explain and discuss objectives, results and relevance of their project research, (iv) plan and organize experimental work and reports to meet deadlines. The candidate must be proactive in resolving research challenges and be prepared to collaborate with other research partners at NCSU.

Information.
For further information, please directly contact: Dr. Nathalie Lavoine, E-mail: nmlavoin@ncsu.edu.

Application.
Send your application per Email to Dr. Lavoine. The application should be written in English and include a CV, specifying 2/3 references with contact information, and a cover letter.

References.