Announcing the Final Examination of Mikhael Soliman for the degree of Doctor of Philosophy

Time & Location: April 6, 2018 at 2:00 PM in Research I 101 - Training Room
Title: Advanced Nanoscale Characterization of Plants and Plant-derived Materials for Sustainable Agriculture and Renewable Energy

The need for nanoscale, non-invasive functional characterization has become more significant with advances in nano-biotechnology and related fields. Exploring the ultrastructure of plant cell walls and plant-derived materials constitutes such a case, as the lack of tools to deepen understanding of molecular interactions taking place within the cell wall layers is hindering advances in materials design for sustainable applications. This consideration in turn addresses solutions aimed at preserving the food-energy-water nexus.

In this dissertation, the introduction presents the broader impact of the work and its relation to the food-energy-water nexus. Chapter 2 focuses on the effect of mechanical stresses on plants. The natural adaptation of plants to the effects of gravity in Poplar wood is explored. Using a multiscale characterization approach, we explore variations in the properties of cell walls throughout a single cross section of Poplar. Intricate variations in Raman bands of cellulose and lignin are highlighted using statistical analysis. Furthermore, we show that the sensitivity of advanced atomic force microscopy techniques to nanoscale variations within the individual cell wall layers can unveil details not attainable with common analytical tools.

Chapter 3 presents examples of the effect of chemical stresses on plants. In particular, the effect of Zinc-based pesticides on citrus plants is considered. Disease management of greening disease, or Huanglongbing, is critical as the citrus industry is facing a threat jeopardizing the efficacy of standard pesticides. We discuss the uptake and translocation of novel zinc-based treatments in the citrus seedlings. The distribution of the treatment inside the plant, as well as its presence locally in the vascular system is also studied. This is important since the bacteria colonize the phloem vessels. The effects of these treatments on the plant are also considered.

Chapter 4 considers the role mechanical and chemical stresses have in plants and discusses the ability to engineer biomass for valorization. Valorization of plants, in this work, covers the broader scope of biofuel production, added-value products, and food-related production. To illustrate this concept, we consider the examples of films produced from lignocellulosic biomass and of growth promoters enhancing tomato crop yields.

Lastly, we provide an overall summary of the work and conclude with future directions and broader impact of the advances achieved in the scope of the reported work.

Major: Materials Science and Engineering

Educational Career:
Bachelor's of Materials Engineering, BS, 2010, The German University in Cairo

Committee in Charge:
Laurene Tetard, Chair, Physics
Swadeshmukul Santra, Chemistry
Raj Vaidyanathan, Materials Science and Engineering
Hyeran Kang, Materials Science and Engineering
Lei Zhai, Chemistry
Karin Chumbumuni-Torres, Chemistry

Approved for distribution by Laurene Tetard, Committee Chair, on March 24, 2018.

The public is welcome to attend.