Preface

Although occurrence of nanoscale aggregates of cellulose upon acid hydrolysis was recognized in the middle of the past century, characterization of nanoscale phenomena was limited. As methods for observing and characterizing such systems have been developed, the cellulose science community has applied them. Much progress has been made in the past two decades. The Anselme Payen Award Symposium at American Chemical Society's 2016 spring meeting was held in recognition of pioneering contributions in the field by Akira Isogai. The theme was: "Nanocelluloses, their Preparation, Properties and Applications." Many distinguished investigators contributed to it, and the present volume provides a representative selection.

Nanocelluloses are the point of focus for many research programs in laboratories around the world. This is because of the abundance of celluloses as the primary structural components in plants, as well as their unique properties. They allow preparation of nanocelluloses of multiple forms with properties that can have significant commercial value. The diversity of the contents in these proceedings reflects the much wider range of parallel investigations ongoing in many academic, industrial, and national laboratories devoted to both agriculture and manufacturing.

An important point that must be kept in mind is that many of the traditional paradigms applied in cellulose science were established in the middle of the past century. They must be reexamined and in some cases abandoned. Many of them are rooted in physical chemical concepts that were developed early in the 20th century. At the nanoscale, many of the variables that are commonly regarded as intensive (such as specific heat) become dependent on dimensions. This effect is well known in submicron colloidal silver and gold, which are red when smaller than 100 nm and yet are purple or blue as diameters increase. The changes in color reflect changes in size. While size will not influence the color of cellulose because it does not absorb at wavelengths more than 200 nm, its specific heat, as well as chemical potentials, are certain to be affected.

Another key consideration is the issue of crystallinity. The crystalline nanocelluloses, commonly referred to as CNCs, are often reported to be about 4 nm in diameter. The number of cellulose chains at the surface of the fibril is a significant fraction of the total. Yet the criterion for definition of crystalline phases is that the amount of matter at the surface be vanishingly small relative to the amount in the bulk. This does not mean that they do not possess order akin to that of crystals, but rather that the terminology must be used with care and qualification. And the qualifications must be applied to both CNCs and cellulosic nanofibers, commonly referred to as CNFs.

The study of CNCs and CNFs is in its infancy, in part because innovation in methodologies is inevitable, but also because of the diversity of the nanostructures in the different native sources of celluloses. While progress has been made in understanding biosynthesis of celluloses, current understanding of the biogenesis of native nanoscale organization is limited. While hierarchic organization in plant cell walls has been characterized at the microscale and at the nanoscale in some species, very little is known about regulation of morphogenesis.

The diversity of sources from which nanocelluloses have been prepared is quite limited. Most studies have focused on celluloses derived from pulps. They represent the most readily available commercial sources, and they are of interest to the forest products industries as opportunities for innovation. Some explorations of agricultural residues as a source are now in progress as well.

The challenges confronting the cellulose science community are well reflected in the collection of investigations reported in these proceedings. The contents represent many different arenas wherein efforts are currently invested in both basic and applications explorations. They also suggest the wide range of questions that have arisen regarding nanocelluloses. And the intent has been to be representative rather than comprehensive regarding ongoing efforts.

Rajai Atalla would like to acknowledge the contributions of his co-editors, both in organization of the symposium and in processing the manuscripts through the review process. Umesh Agarwal undertook responsibility for the logistics associated with both organizing the symposium as well as the processing of manuscripts. He also has made contributions to two chapters. Akira Isogai's pioneering work inspired organization of the symposium, and he contributed to both the proceedings and the review process.

Members of the executive committee of the Cellulose and Renewable Materials Division of the Society also contributed considerably to the success of the symposium. The support of Sheila Murphy and Nicole Brown in particular is greatly appreciated. The guidance and help of the staff of the ACS Books Department was essential to success of our effort. Bob Hauserman, Elizabeth Hernandez, and Anne Brenner greatly facilitated our efforts.

Umesh P. Agarwal
Forest Products Laboratory, USDA Forest Service
uagarwal@fs.fed.us (e-mail)

Rajai H. Atalla
Cellulose Sciences International and University of Wisconsin
rhatalla@wisc.edu (e-mail)

Akira Isogai
University of Tokyo
aisogai@mail.ecc.u-tokyo.ac.jp (e-mail)