Cellulose and chitin biopolymers for sustainable bioproducts preparation

Noureddine Abidi, Shaida S. Rumi, Prakash Parajuli, Sumedha Liyanage, Julia L. Shamshina

Fiber and Biopolymer Research Institute, Texas Tech University, Lubbock, Texas, USA 79403

Abstract

Cellulose and chitin are two biopolymers widely available as biomass. Cellulose is a homopolymer composed of repeating units of β-D glucopyranose linked together by 1→4 glyosidic bonds (Figure 1-a). A single cellulose polymer chain is comprised of several hundreds to over ten thousand repeating glucose units. Because of the extensive intra- and interchain hydrogen bondings and van der Waals forces, cellulose chains are assembled into highly crystalline micro-fibrils. Cellulose is a promising candidate as a raw material for the preparation of various "green" materials such as fibers, films [1] (Figure 1-b), food casing, membranes, porous materials [2] (Figure 1-c), nanocrystals [4], and sponges, which are currently predominantly prepared from petroleum based synthetic polymers. Chitin is made of β-(1→4)-linked 2-deoxy-2-acetamido-D-glucose units (Figure 1-d). It is obtained from crustacean shells, skeletons of insects, fungi, etc., and is applicable in various fields including biomedicine [5].

Because biopolymers do not melt, their transformation to bioproducts requires dissolution in a solvent system which does not lead to polymer degradation. In this presentation, we will review emerging applications of cellulose and chitin to prepare sustainable bioproducts as potential alternatives to non-renewable and non-biodegradable polymers.

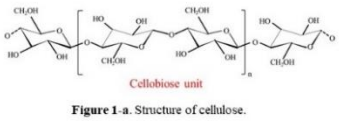

Figure 1-a. Structure of cellulose.

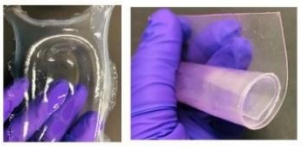

Figure 1-b. Hydrogels and films prepared from cellulose.

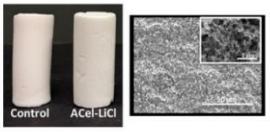

Figure 1-c. Aerogels prepared from cellulose.

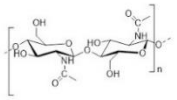

Figure 1-d. Structure of chitin.

Recent Publications

1. S.S. Rumi, S. Liyanage, N. Abidi. Cellulose, 28 (2021) 2021-2038.
2. P. Parajuli, S. Acharya, J.L. Shamshina, N. Abidi. Cellulose, 28 (2021) 7559-7577.
3. P. Parajuli, S. Acharya, Y. Hu, N. Abidi. J. Appl. Polym. Sci. 2020; e48975.
4. J.L. Shamshina, N. Abidi. Green Chem. 23 (2021) 6205-6222.
5. J.L. Shamshina, R.S. Stein, N. Abidi. Green Chem. 23 (2021) 9646-9657.

Biography

Dr. Noureddine Abidi is Professor of Biopolymers and Bioproducts and Director of the Fiber and Biopolymer Research Institute at Texas Tech University. His focus is on the chemistry of biopolymers, particularly cellulose, and their transformation to advanced materials. He holds a "Habilitation à Diriger les Recherches" from the University of Haute Alsace in France and a Ph.D. from the University of Montpellier II in France. Dr. Abidi has generated 134 refereed journal publications and book chapters, 3 books, more than 160 presentations, 7 patents/provisional patents. Abidi has served as PI or co-PI on funded research grants totaling more than $17M. He received several awards such as Texas Tech University Chancellor's Council Distinguished Research Award, Texas Tech University Outstanding Research Award, Texas Tech University President's Mid-Career Award, Fulbright US Scholar Award, Texas Tech University Integrated Scholar Award, American Chemical Society Cellulose and Renewable Materials Division Fellow.

E-mail: noureddine.abidi@ttu.edu