

The study of properties of Cellulose by different spectroscopic methods

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Abstract : Cellulose is environment friendly substance sourced from plants. Cellulose is inherently non- toxic. It is a polysaccharide compound having carbon, hydrogen and oxygen. It is organic biopolymer containing more than 30,000 glucose unit. Cellulose is a complex carbohydrate having formula $(C_6H_{10}O_5)_n$. The Cellulose consists of hydrogen atoms are arranged in the axial position, whereas the hydroxyl group arranged in equatorial position. The individual chains are bound together in the microfibrils by hydrogen bonds. Cellulose is most prevalent on earth and biodegradable in nature. Microcrystalline cellulose used in this experiment. Here we discussed the properties and characterization of cellulose. Some methods of characterization used for microcrystalline cellulose such as Fourier transform spectroscopy (FT-IR), Scanning electron microscopy (SEM). Cellulose contributes to sustainability efforts. Various applications of cellulose are in paper industries, food industries, building materials and pharmaceutical industries. Cellulose is a strong structural material capable of enduring harsh environmental conditions due to the stability of its α -glycosidic linkage.

(Keywords : Biodegradable, Sustainability, Fourier transform spectroscopy, Scanning electron microscopy, microcrystalline cellulose).

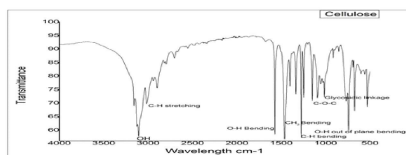
Introduction

Cellulose is a complex carbohydrate and most abundant non toxic polymers on the earth. Cellulose having linear chain of α (1-4) linked D glucose units¹⁻². Cellulose provides the structural support and rigidity to the plants. The monomers of glucose are organized in straight chain and

allowing hydrogen bonds to form between adjacent chains, resulting in strong micro fibrils. A biofilms of cellulose has been secreted by certain microorganism and bacteria [3]. In plants, cellulose is synthesized at the plasma membrane by enzymes complexes called cellulose synthase. In cotton fibers, 90 % cellulose is present, 40% in wood and 57% in dried hemp⁴⁻⁶. Cellulose is the most ample consistently transpire biopolymers⁷⁻⁸. The vital component of the numerous natural fibres such as cotton and higher plants⁹⁻¹⁰. Cellulose comprise prolonged chains of anhydro-D-glucopyranose units (AGU) accompanied by each three hydroxyl groups per AGU having the exception of the terminal nodes. The tremendous ability of cellulose is strong, reproducible, recyclable and biocompatible¹¹. In the environment, cellulose contributes to the carbon cycle through decomposition, primarily by fungi and bacteria. To improve the process abilities, the Chemical modifications of cellulose were performed which can be developed for specific industrial applications¹². Various properties of cellulose are tasteless, odorless and hydrophilic having contact angle 20- 30 degrees¹³. Reacting cellulose with mineral acid in very high temperature can be split into glucose unit¹⁴. Microcrystalline commonly used in vitamin pills, tablets. Microcrystalline cellulose termed for refined wood pulp. Micro fibrils of microcrystalline cellulose consists high degree three dimensional internal bonding resulting insolubility in water and resists the reagents¹⁵⁻¹⁶

Materials and Methods

Microcrystalline cellulose of Sigma-Aldrich was used in this experiment. Microcrystalline was synthesizing α -cellulose precursor¹⁷. The methods used for the preparation of MCC are Reactive extrusion, enzyme-mediated, mechanical grinding, ultrasonication, steam explosion, and acid hydrolysis. Sulfuric acid, Hydrochloric acid and Hydrogen bromide used for latter procedure. These chemical's function are to eliminate the amorphous areas that separate the crystalline domains. The polymerization degree is less than 400.

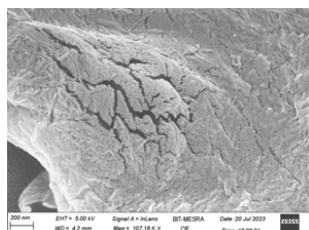


Characterization of Cellulose

1. FTIR graph of cellulose
The peaks around 3106 cm^{-1} , 3015 cm^{-1} , 2898 cm^{-1} , 2703 cm^{-1} , 1571 cm^{-1} , 1462 cm^{-1} , 1401 cm^{-1} , 1335 cm^{-1} , 1246 cm^{-1} , 1150 cm^{-1} , 1089 cm^{-1} contribute to -OH stretching of carboxylic group, C-H stretching of alkane, C-H stretching of aldehyde, O-H stretching of alcohol, C=C stretching of cyclic alkene, C-H bending of alkane, O-H bending of alcohol, O-H bending of alcohol, C-N stretching of amine, C-O stretching of tertiary alcohol and C-O stretching of primary alcohol respectively.

The FTIR graph help to detect the functional group present in the cellulose.

1. SEM report of Cellulose



Surface morphologies of cellulose can be detected through SEM analysis. Cubical rod structure of cellulose detect in the above figure. It has unique characteristic of porosity and amorphous nature of cellulose.

Applications

Cellulose is long established in the domain of textile, paperboard, paper industries, and card stock. It is used in various forms of transformer insulation, cables and other electrical equipments¹⁸. Alternative methods employed the diverse use of inactive fillers like microcrystalline cellulose and cellulose in drug delivery medicines¹⁹. Cellulose gives high potency to building materials²⁰. Cellulosic matrices like biochar and activated carbon are utilized for water and soil treatment due to their excellent adsorption properties. They are particularly effective at removing heavy metals, organic pollutants and nutrients from their environment, making their valuable tools in environment remediation efforts.

Conclusion

Cellulose has amazing properties are chiral, tasteless, and odourless; provide strength to cell wall of the plant, recyclable, toxin-free, and environment-friendly and water retaining capacity. Cellulose based material is biodegradable in nature. Insulation of cellulose provide green product. Cellulose does not show negative impact on environment and helps in sustainable development. Cellulose stands as a cornerstone of sustainable development, offering a renewable and versatile resource with various applications. From recyclable packaging materials to biofuels, its ecofriendly properties contribute significantly to reducing environmental impact and fostering a more sustainable future.

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