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CELLULOSE THE 'DNA' OF PAPER

Cellulose, the most abundant organic compound found on earth, is nature's building block, being the basic structural material of all trees and plants.

A long-chain polymer, comprising of repeating chains of carbon-hydrogen-oxygen units, Cellulose is also the most basic and important constituent of paper.

WHAT MAKES CELLULOSE 'SPECIAL' FOR PAPERMAKING

The Cellulose fiber is itself made up of multilayers of very small thread like structures called 'fibrils'. These fibrils are exposed by beating / refining of the fibers thereby providing a very large area for bonding.

Chemically the cellulose chain bristles with polar - OH groups. When soaked in water, hydrogen bonds form among the hydroxyl (OH) groups on the surface of the fibers causing them to cling together.

Removal of the water (drying) causes these bonds to strengthen even more, resulting in a strong fiber mesh or sheet that we call 'paper'.

The following properties of cellulose makes it suitable for papermaking :-

High tensile strength >> Suppleness >> Water insolubility >> Hydrophilic properties >> Chemical stability >> Colorlessness (White)

WORKING WITH CELLULOSE

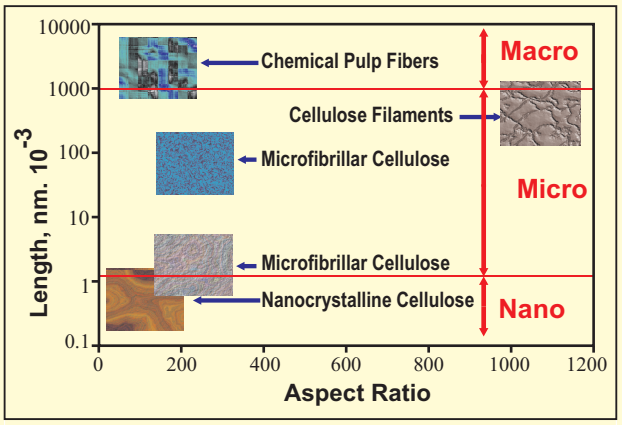
Cellulose is highly interesting from a material scientist point of view, given its abundance, renewability and low cost.

Various chemical, mechanical and biological processes are used to unlock the potential of the nano-material that is the integral part of this natural polymer.

Individual processes yield distinct products with different morphologies ranging from nanocrystalline cellulose (NCC), to various forms of what might broadly be described as nanofibrillar cellulose (NFC) or microfibrillar cellulose (MFC). Each exhibits different properties and potential for application in a wide range of high-value products. Whereas cellulose nanocrystals (CNC) deploys at the nano scale, CF is typically at the micro scale.

CELLULOSE FILAMENTS (CF)

Cellulose filaments are the new wood-based biomaterial that will have an immediate impact on the whole forest industry since they integrate well with other materials, offering high



Cellulose Material World *Source : Celluforce*

strength, light weight and flexibility. They can be used as a lightweight strengthening additive to produce lower-cost commercial pulps, papers and packaging as well as tissue products and towels.

CF is fully recyclable, and compatible with water-based products like wood pulp. This allows the manufacturing of a super pulp that can be directly used in paper products.

FP Innovations, the Montreal-based national pulp and paper researcher, and Kruger Inc., (*a major producer of tissue products, packaging, specialty papers)* have joined forces to build a $43 million five-tons-daily cellulose filament demonstration plant in Trois-Rivières.

Because of CF's high strength and strengthening power, introducing only a small quantity of it to pulp fibers has been found to greatly improve inter-fiber bond strength, compression strength, tensile strength, and stretch of the paperboard products.

"Compared with the strength polymers conventionally used in paperboard mills, the addition of CF to a recycled pulp furnish improves paperboard strength even under humid environments," says FPInnovations.

Cellulose filaments can also be used as a lightweight strengthening additive to produce lower cost commercial pulp, paper, tissue and towels.

NANOCELLULOSE

Nanofibrillated cellulose (NFC), or **microfibrillated cellulose (MFC)**, is a material composed of nanosized cellulose fibrils with a high aspect ratio *(length to width ratio)*. It is pseudo-

INDUSTRY NEWS	***BILT Graphic Paper Products, Bhigwan*** was the recipient of the **PPI "Environmental Award"** at the **RISI Annual Conference** held in Dubai in December 2013.

plastic and has the appearance of a highly viscous, shear-thinning transparent gel. It is produced by delaminating cellulosic fibers in high-pressure homogenisers. Nanocellulose fibers can be extremely tough, with a stiffness comparable to that of Kevlar.

According to **VTT Technical Research Center** - Finland, nanocellulose would soon displace wood pulp in paper, allowing producers to increase mineral fillers percentage in their furnish, cutting production costs by around 3%. Higher filler content can lead to upto 30% lower drying energy, cutting the carbon footprint of paper by 15% or more.

Says the Head of Research at VTT *"It's not only cheaper, it's less porous, not so translucent and its printing quality is higher, so in all respects you get a better paper for less money".*

Other areas of application being investigated are surface sizing and barrier coating, in food packaging.

Since its first development in 1980, continual research at **Innventia**, has resulted in reduction of energy requirement making the commercial production of nanocellulose viable.

The US Department of Agriculture Forest Service, claims, it should be possible to produce nanocellulose very competitively.

In India, a project sponsored by Indian Council of Agricultural Research with collaborative research between **Central Institute for Research on Cotton Technology (CIRCOT)** Mumbai and **Institute of Chemical Technology** Mumbai has led to setting up of a Pilot Plant for Nanocellulose production at CIRCOT.

NANOCRYSTALLINE CELLULOSE (NCC)

Cellulose consists of both crystalline and amorphous elements. The amorphous elements can be removed via several types of chemical reaction, such as hydrolysis. The process results in the release of nanocrystalline cellulose (NCC). NCC consists of rigid, needle-like cellulose crystals, measuring 3-10 nm across and 100-300 nm in length, which can be processed into solid flake, liquid and gel forms.

NCC increases the strength and stiffness of materials, making it attractive for a number of new applications. NCC is stronger and lighter than steel, recyclable and sustainable, and also non-toxic. It can also alter the surface of paper, improve packaging and building products, and make these products more environmentally friendly.

CONCLUSION

'Cellulose' continues to fascinate the scientist with its immense possibilities. Nanofibrillated cellulose is a material for the future.

With new technology based on nanofibrils, the general view of cellulose-based materials as only a low-value raw material for paper, tissue and packaging will be challenged, and cellulose will surely find its way up the value chain.

Surface modification of the fibrils will play a crucial part in optimizing their performance in many varied applications. Specially designed polymers can be utilized to tailor surface properties of cellulose-based materials both to optimize its properties for certain applications, or to give them completely new properties that were earlier not possible with traditional technology.

If the forest industry gets into partnerships with companies that use its pulp for high-tech purposes, they will be doing something more than papermaking. It will provide the added fillip to good forest product management.

This article can be considered a sequel to the earlier article ***"The Magic of Cellulose"*** *by Mr Ved Krishna* ***(Snippets-Jan. 2013).***

QUOTABLE QUOTE	***"No bird soars too high, if he soars on his own wings"*** *- William Blake*
SCRABBLE	Rearrange the **letters** for **two new words** relating to the paper industry. (Hint : *Killing the bubbles at the start !*) **DO PEEL UP FARM MILL** First correct answer will win a Parker Vector Roller Pen (Maximum two prizes for one person in a year). Email your answers to snippets@wirefabrik.com by 20th February, 2014.
WINNER JAN'14	**Mr. S. Mogaveer, AGM (Duplex Board), The West Coast Paper Mills Ltd.,** Bangur Nagar, Dandeli, Dist. U.K. - 581325 **Answer : CROSS PINE FRINGE : REFINING PROCESS**
?QUIZ	**An Optical Brightener when used in the size press is positively affected by the following. (tick the correct options)** **a) Titanium Dioxide b) Oxidized starch c) Polyvinyl alcohol d) PCC** Email your answers to snippets@wirefabrik.com by 20th February, 2014.
WINNER JAN'14	**Mr. Mohd. Naseem, GM-Production, Middle East Paper Co.,** P.O. Box - 32913, Jeddah - 21438, K.S.A. **Quiz :** A deinking chemical and a defoamer are both surfactant based. Which will have a lower HLB value ? **Answer :** A defoamer will have a lower HLB value compared to a deinking surfactant.
Prizes	**1. Best / first correct answer** received will win one-year subscription to **IPPTA Journal** *(Maximum one prize for one person in a year).* **2. Best of the 12 monthly winners** in a year, will win one-year subscription to **Paper 360° Magazine, USA.**
☺ ***Apt Definition !***	A six-year old boy writing about 'Marriage' *"Marriage is when you get to keep the girl you are playing with and don't have to give her back to her parents at the end of the day".*

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