NANOCELLULOSE PRODUCTION:
Eco-friendly & energy-efficient
CIRCOT TECHNOLOGIES

CIRCOT leaflet:
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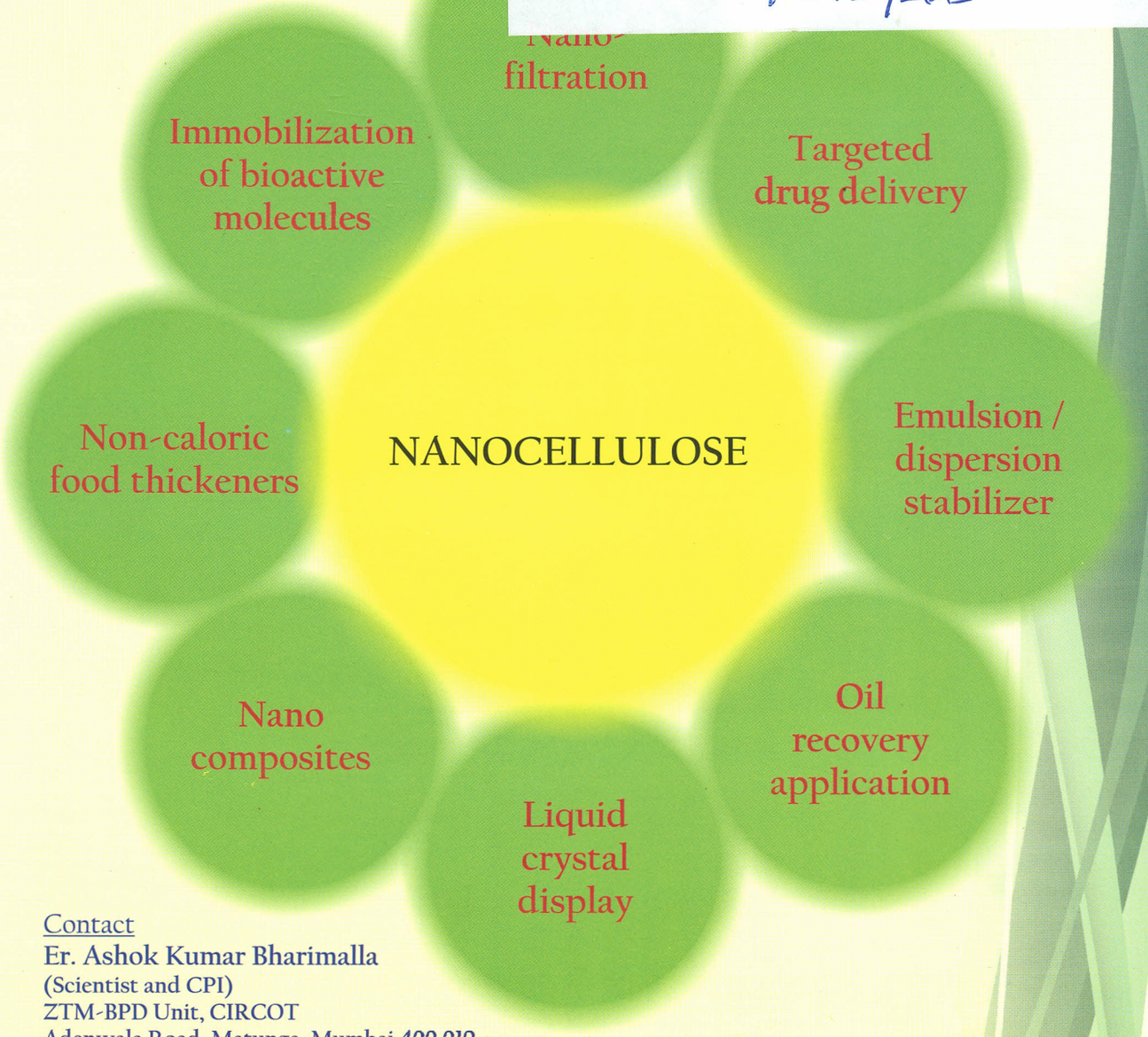

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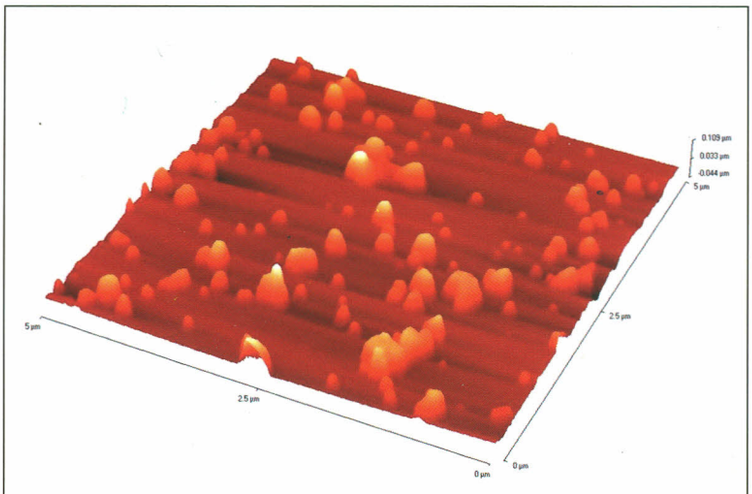
Background

Cellulose is the polydispersed linear polymer of ß-(1,4)-D-glucose units and the most abundant natural polymer on Earth. Nanocellulose refers to cellulosic fibres that are broken down to the nano-size range. The major importance of nanocellulose is due to their unique properties, like very high mechanical strength and new optical properties. Cotton, agro-biomass and wood are the major sources for production of nanocellulose.

Depending on the size and shape, nanocellulose is of two major types namely, cellulose nanocrystals and nanofibres (e.g., microfibrillated cellulose). While cellulose nanocrystals are short rod like whisker-shaped particles and have low aspect ratio that are obtained by hydrolysis, microfibrillated cellulose/nanofibres have high aspect ratio and obtained by mechanical shearing action. Due to the intrinsic architecture of cellulose in the plant biomass, the process for production of nanocellulose becomes highly energy intensive. Conventionally, they are produced by concentrated acid hydrolysis of cellulosic materials. Recently, mechanical processing with various pretreatments are being attempted for production of nanocellulose on a pilot scale.

In-line with the need of the hour, CIRCOT has developed novel processes for production of nanocellulose from cotton fibres and linters under a research grant from Indian Council of Agricultural Research (ICAR) through its World Bank funded National Agricultural Innovation Project (NAIP). These processes are being validated for other sources of raw materials like wood pulp and



Nanocellulose by Anaerobic Microbial Process

Technologies Available at CIRCOT for Nanocellulose Production

Mechanical Process

The mechanical process involves processing of cotton fibres by a high shearing action to form nanofibrillated cellulose. Since this process consumes huge energy, following pretreatments have been developed at CIRCOT for making the process energy-efficient.

- Enzymatic Pretreatment (Reduce energy consumption up to 40%)
- Chemical Pretreatment (Reduce energy consumption up to 35%)

Biological Process

Biological agents, either microbes or enzymes are used in the controlled hydrolysis of cellulose, resulting production of nanocellulose. Two different routes have been developed at CIRCOT as given below.

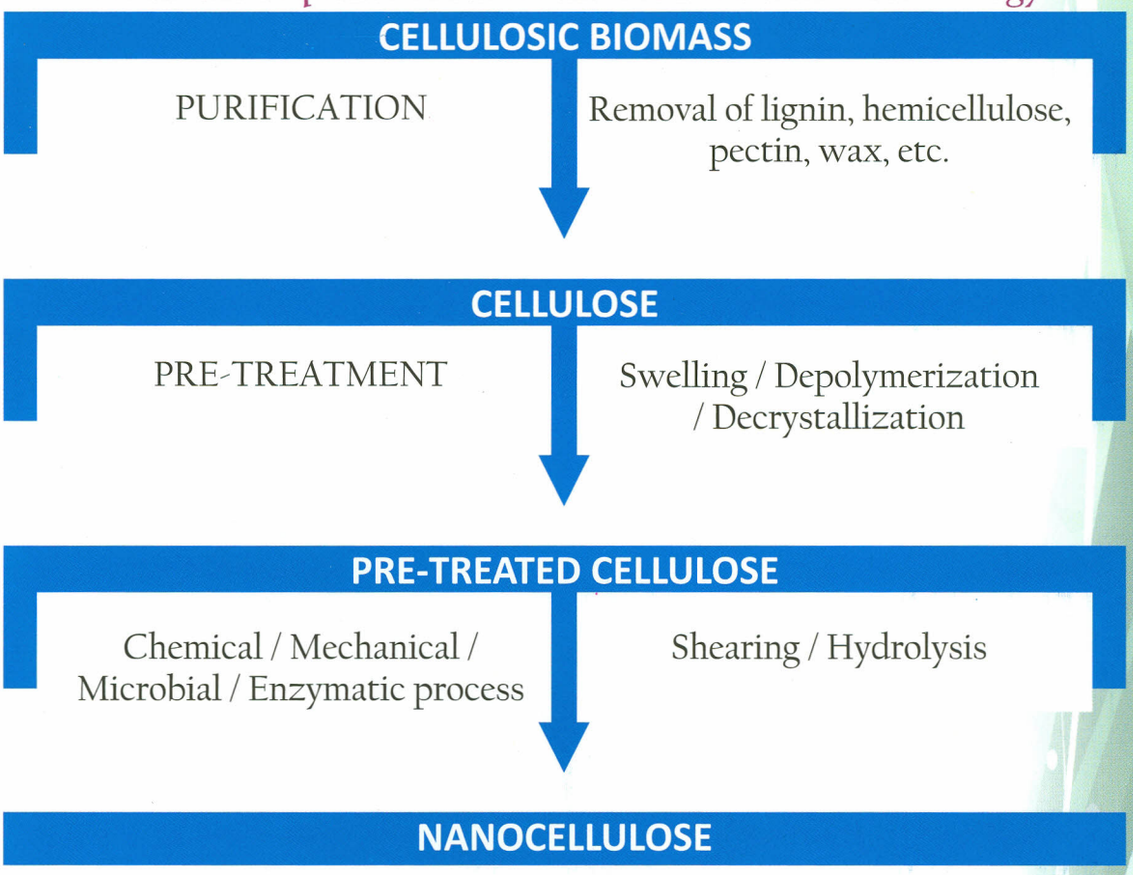
Microbial Process

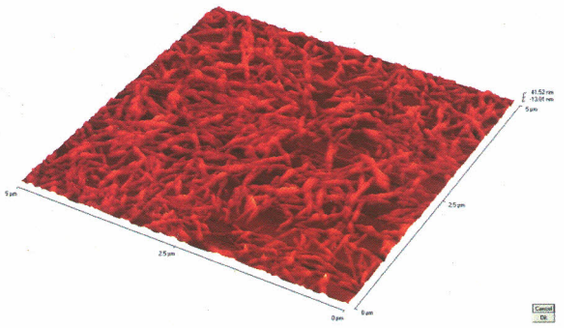
In the microbial mediated process (both aerobic and anaerobic), cellulase enzyme secreting microbes act as an agent for controlled hydrolysis of cellulose.

Enzymatic process

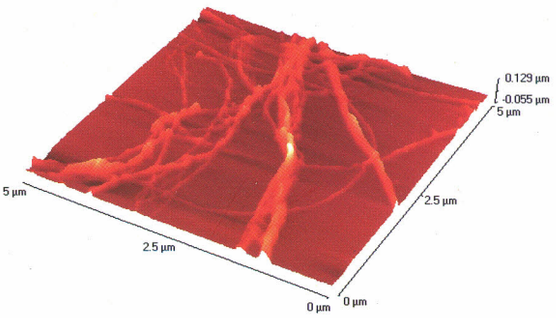
In the enzymatic process, specific enzymes are used for controlled hydrolysis of cellulose in a specially designed Membrane Reactor for production of nanocellulose.

Schematic Sequence of Nanocellulose Production Technology

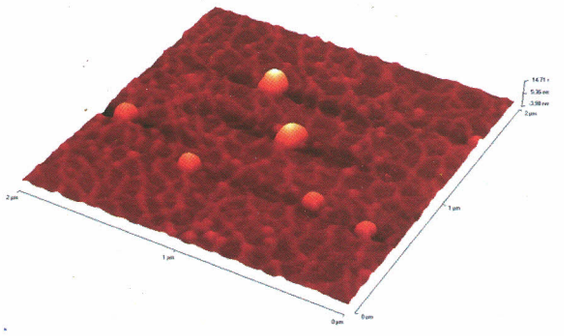




Nanocellulose by Aerobic Microbial Process



Nanocellulose by Mechanical Process



Nanocellulose by Enzymatic Process

Application of Nanocellulose in Composites

Nanocellulose is being used as fillers in biopolymeric films made from starch, carrageenan, guar gum and chitosan to improve their mechanical properties, and to reduce water-vapour and oxygen permeability. The surface modified or compatilized nanocellulose promises a better use as fillers in commodity polymers, like polyethylene and polypropylene. Being biological origin, nanocellulose produces an eco-friendly, biodegradable and renewable filler for various nanocomposites.

Services offered by ZTM-BPD Unit of CIRCOT

- Business Incubation
- Entrepreneurship Development Programme
- Technology licensing
- Consultancy

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