



PRODUCTION OF PACKAGING MATERIAL USING RECYCLED FIBERS AND UNBLEACHED SUBABUL SAPWOOD PULP THROUGH NANOTECHNOLOGY

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Abstract

Materials: Fresh wood pulp and recycled pulp (Amazon) were soaked (50:50 , 48h)

Process - Refining: Super masscolloider (SMC) and Lab Valley beater (LVB).

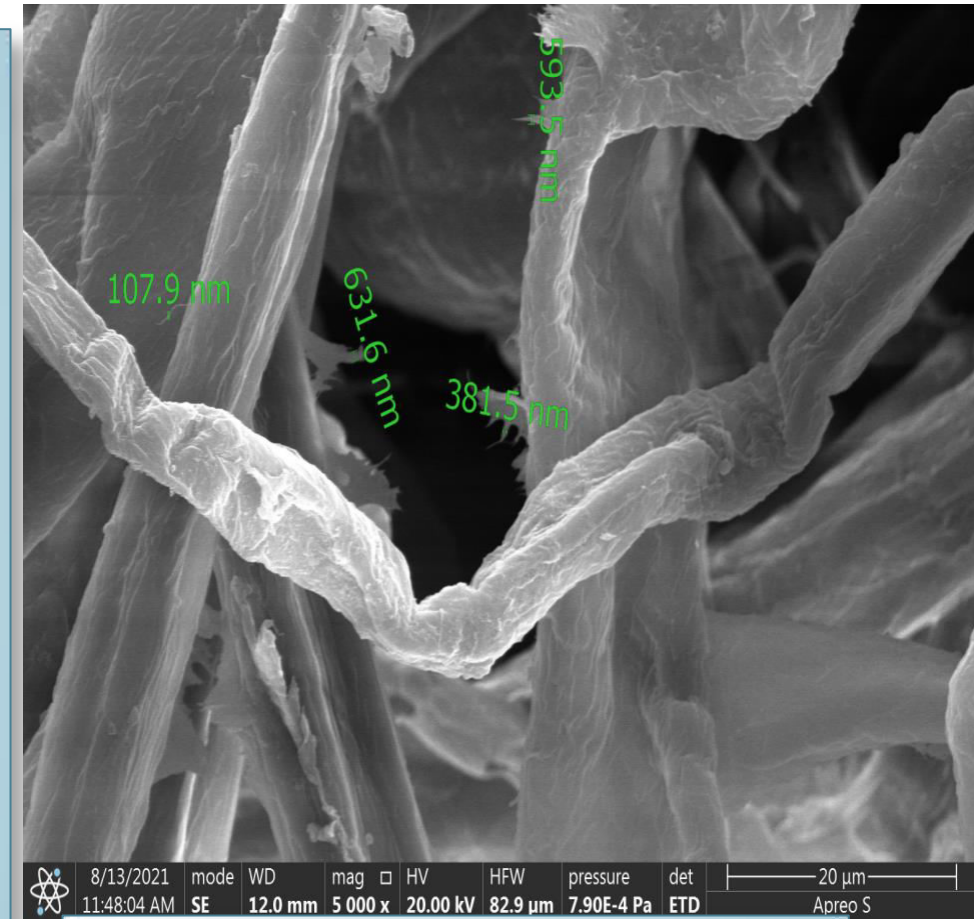
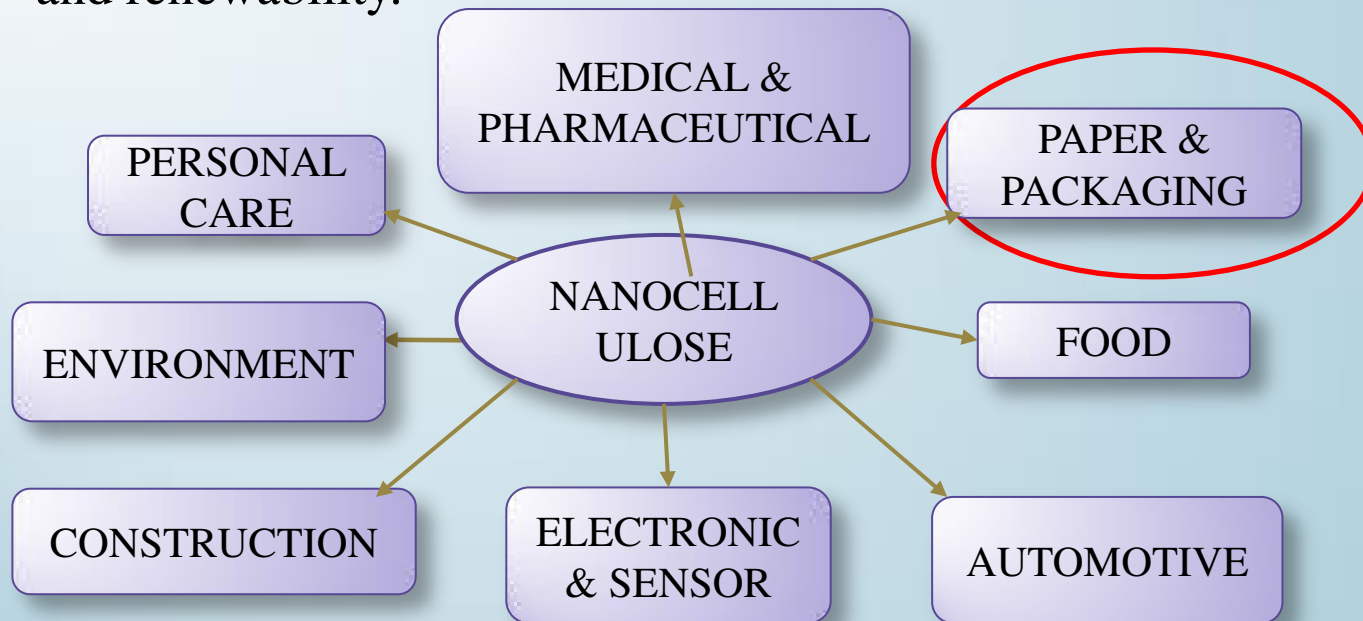
Process-Sheet making: Micro and nanocellulose fibers sheets were made using Vacuum filtration & Whatman filter paper (pore size of 10 μm)

Results: SMC refined sheet revealed high burst strength and low porosity

Conclusion: Potential application in food packaging (paper plates without plastic wrap)

Introduction

- Nanocellulose fibers: high modulus, high specific strength, high surface area, high aspect ratio, biodegradability, biocompatibility and renewability.



Micro and nanocellulose fiber network

Diameter: 100 to 3000 nm

Material and Methodology



Unbleached pulp

Recycled Amazon packaging soaked pulp



Refining

Lab Valley Beater

Super mass colloidier

Micro cellulose pulp

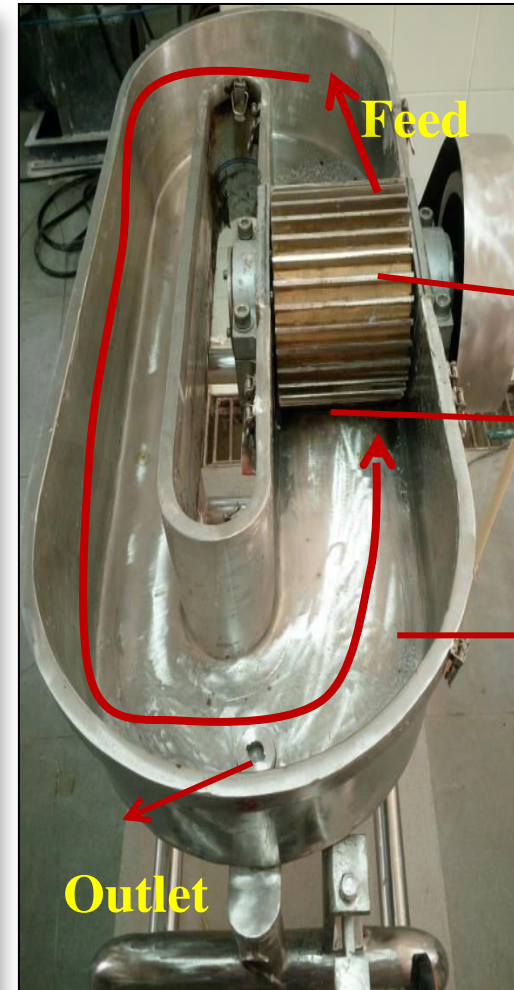
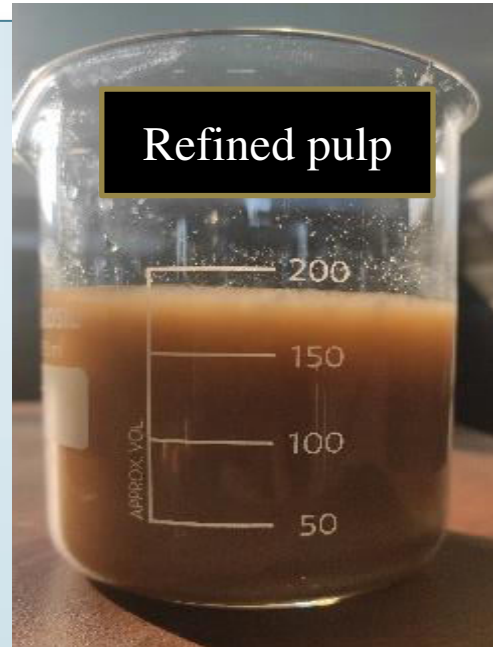
Micro & Nanocellulose pulp

Fabrication of Sheets (Hand sheet former equipped vacuum filtration)

Burst strength, Microscopy, Porosity test

Lab Valley Beater (LVB) Refining

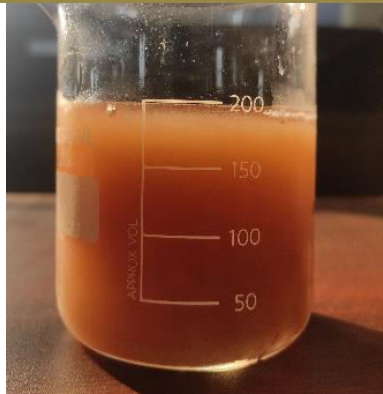
- Load – 5.5 kg.
- Time – 60 min
- RPM – 600
- 50 g of mixed pulp in 5L of water
- Consistency – 10%



Feed basket

Super Masscolloider (SMC) Refining

Slurry after SMC



vortex



Refining clearance, time (min)	Mixed pulp (g)	Water (L)	Consistency (%)
SMC_1 , 15 min	50	5	10
SMC_0.4, 15 min	50	5	10
SMC_0.1, 15 min	50	6	8.33
SMC_0.01, 15 min	50	7	7.14
SMC_0, 60 min	50	7	7.14

SMC is 20.7 degree inclined towards outlet (Smooth flow of product)

Feed

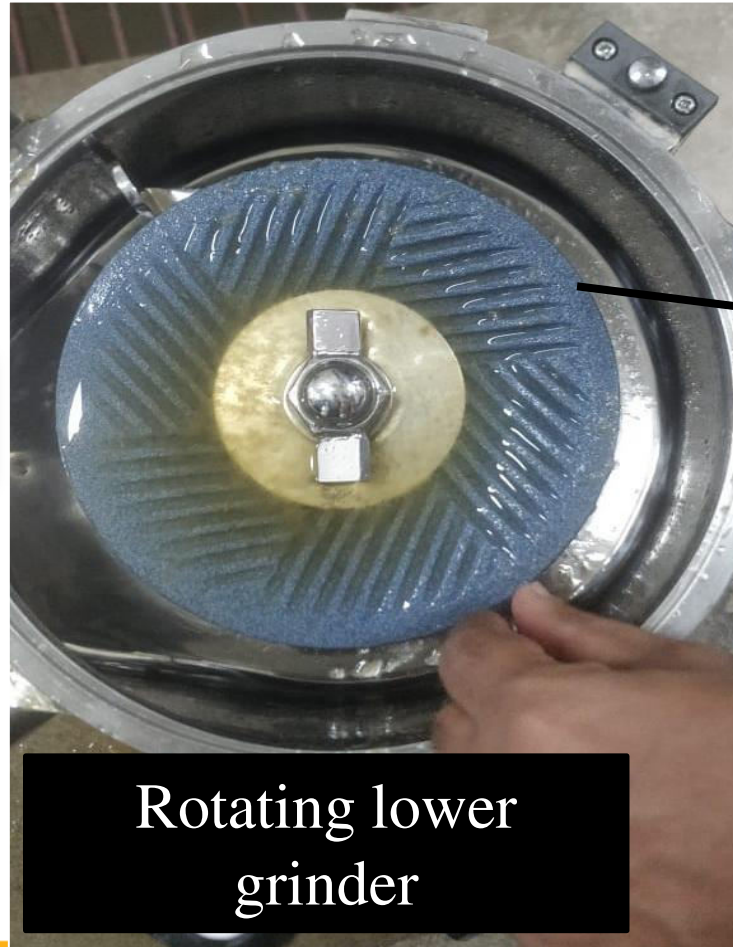
Outlet

To adjust gap

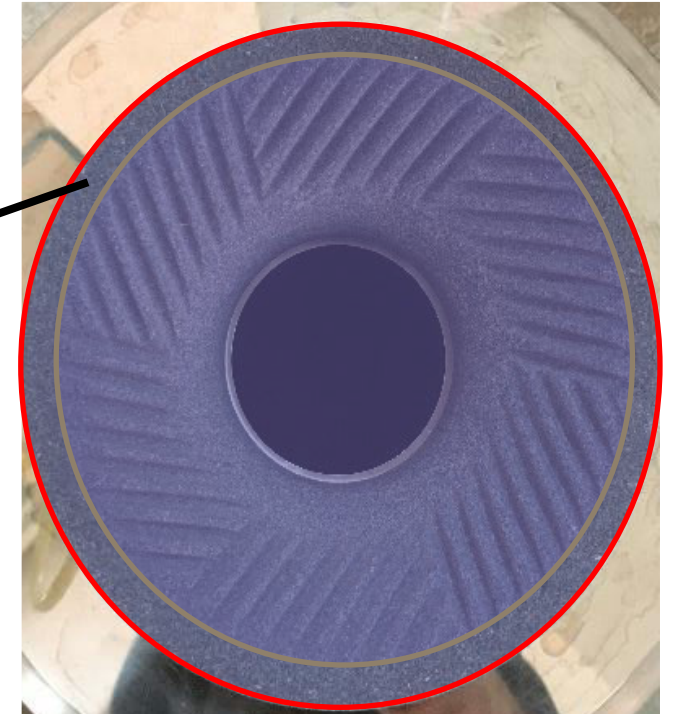


Super Masscolloider (SMC) Refining

RPM - 1000

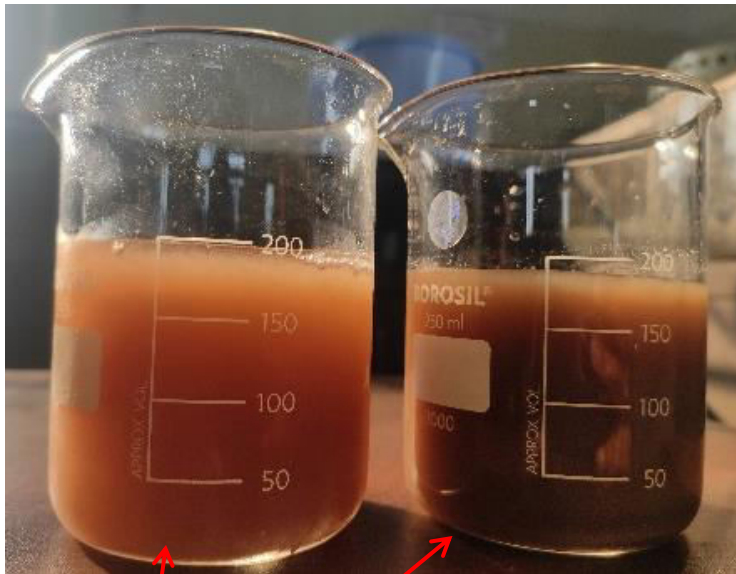


GRINDING
ZONE
17 mm

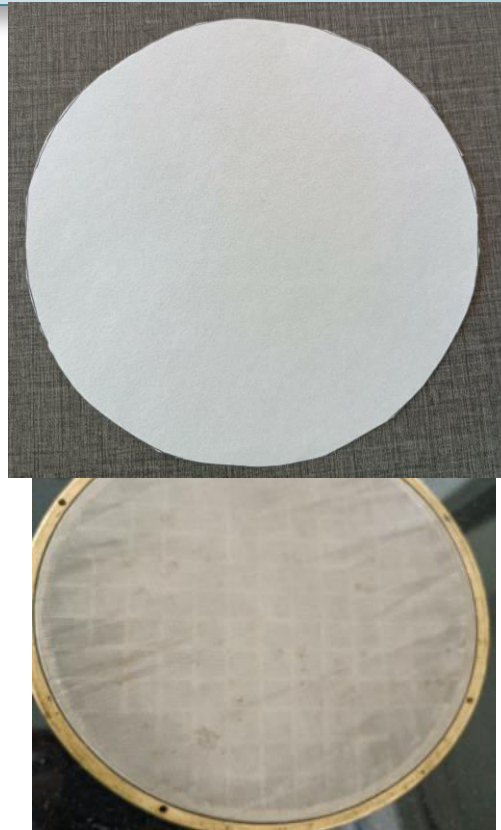


Fabrication of micro/ nanocellulose sheets

- 1000 ml of pulp slurry obtained from LVB / SMC refining is used
- Metal filter (100 μm pores) and Whatman filter Paper (10 μm)



SMC & LVB
refined pulp slurry



Whatman
filter

Metal filter

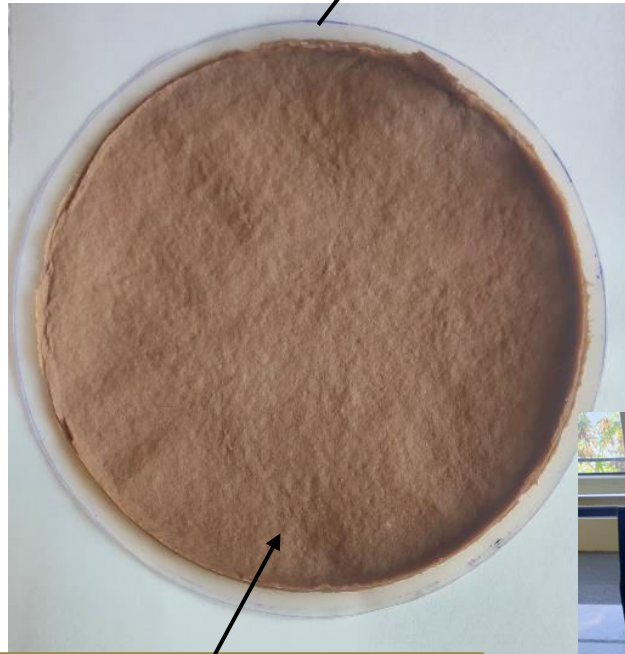
Vacuum



Hand Sheet former

Drying of sheets

Whatman filter Paper



Micro & nanocellulose Sheet before drying

Climatic test chamber

- Temperature : 60 °C.
- Time : 2 hrs.
- Convection Heat drying



Roller (Densification)



Micro & Nanocellulose Sheet after drying

Scanning electron microscopy (SEM) of LVB and SMC sheets

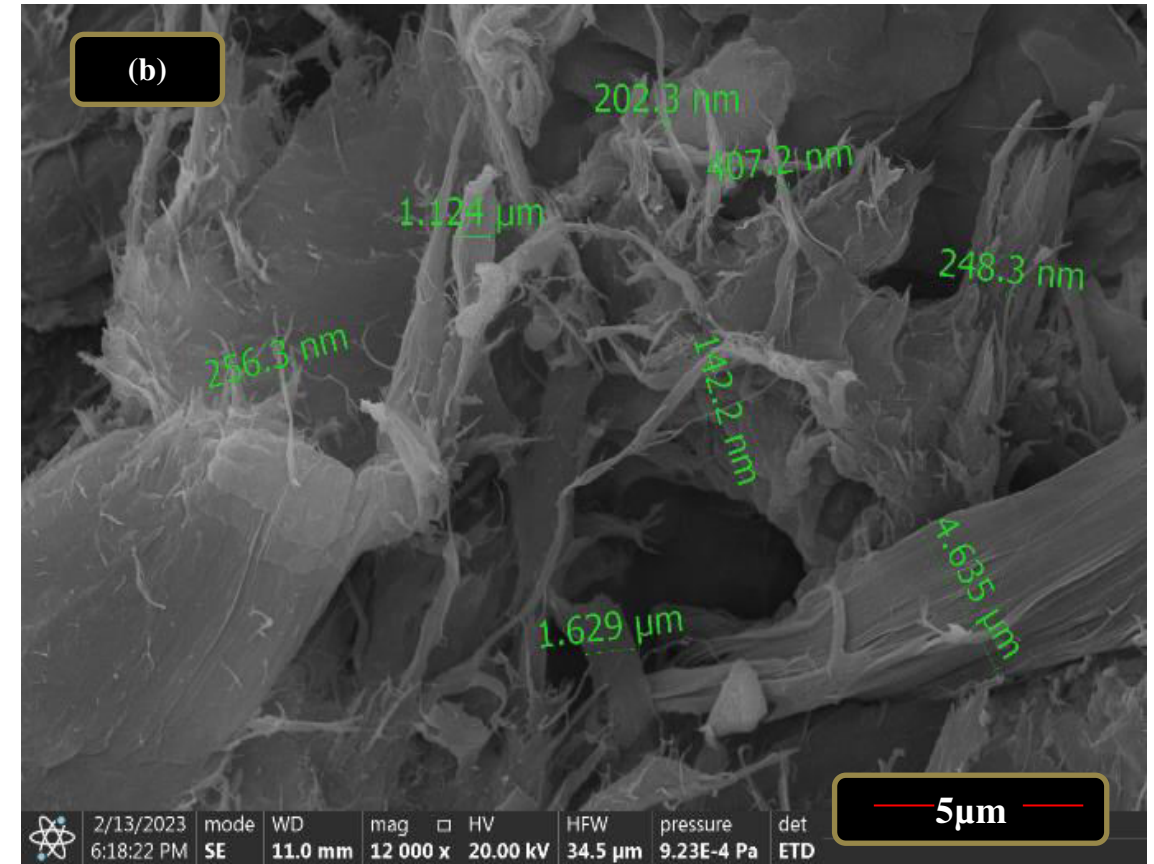
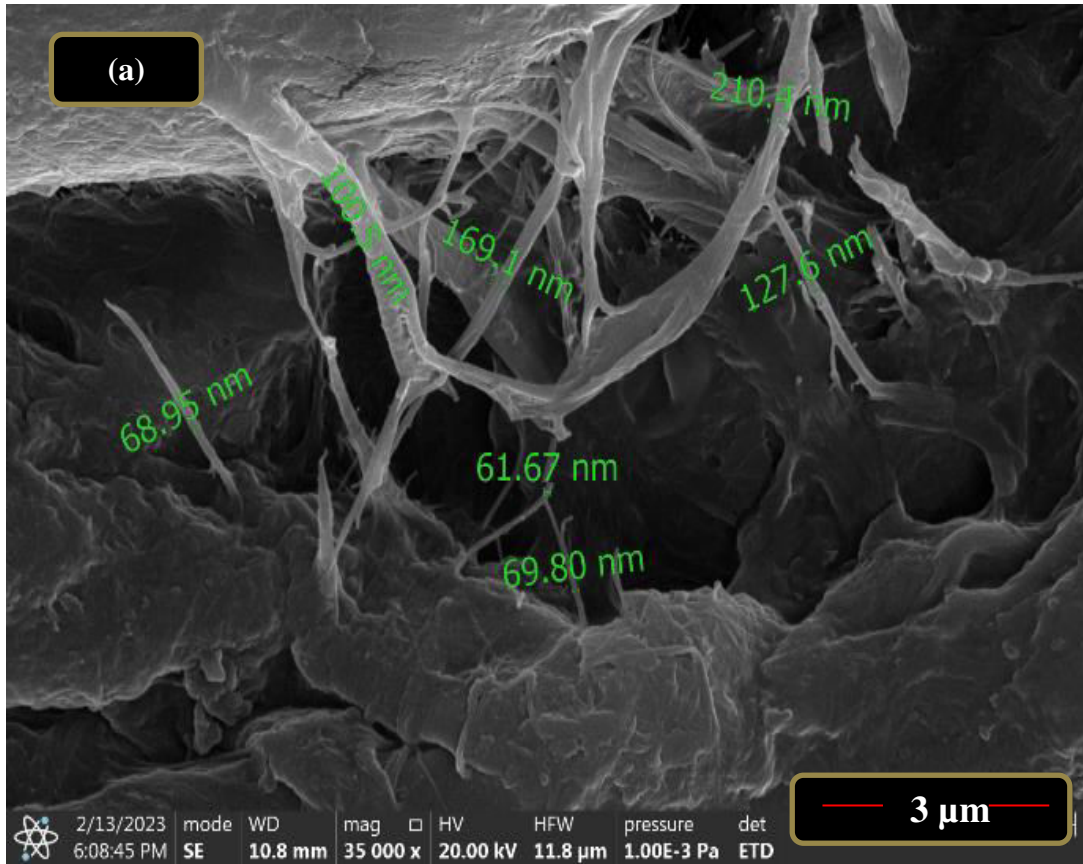


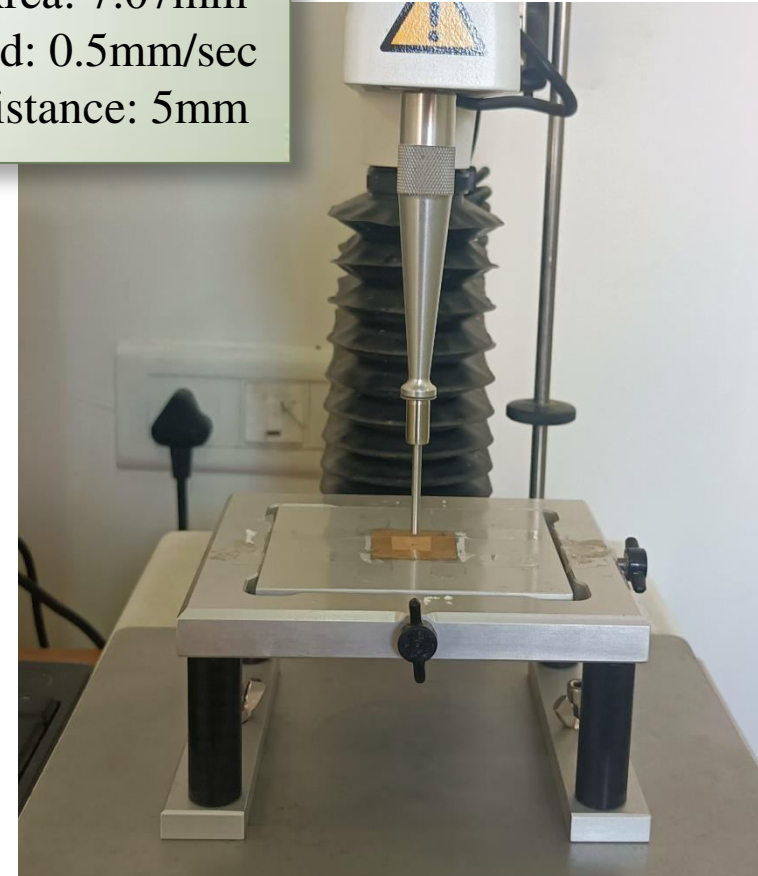
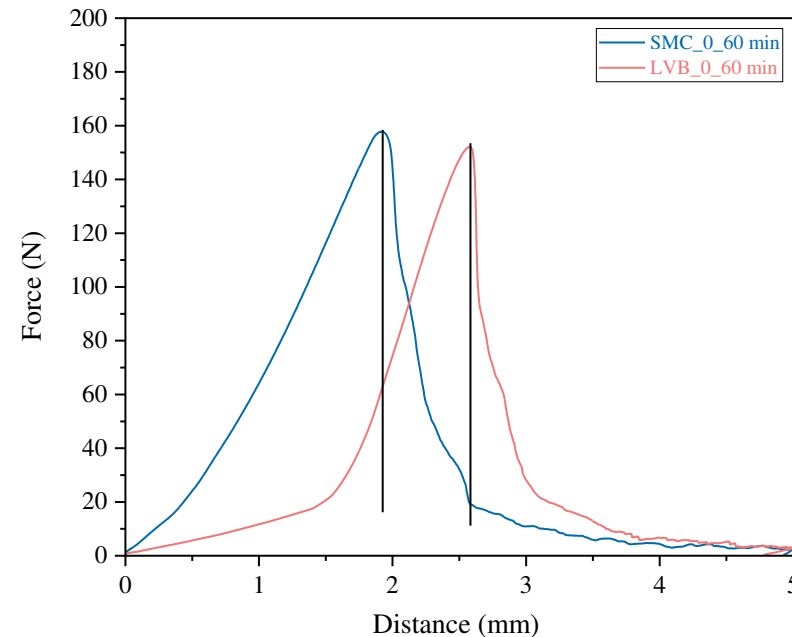
Fig. SEM of sheets made from SMC (a) and LVB (b) refined fibers
Nanocellulose fibers (60-260 nm), Microcellulose fibers (1-5 microns)

Burst strength of sheets

- Burst strength is the maximum pressure a given component can withstand before it bursts or fails destructively under pressure.

Probe: 3mm SS
Contact Area: 7.07mm²
Test Speed: 0.5mm/sec
Target Distance: 5mm

Refining Technique	Burst Strength (N/mm ²)
SMC_0_60 min	22.35 ± 0.88
LVB_0_60 min	19.98 ± 1.54

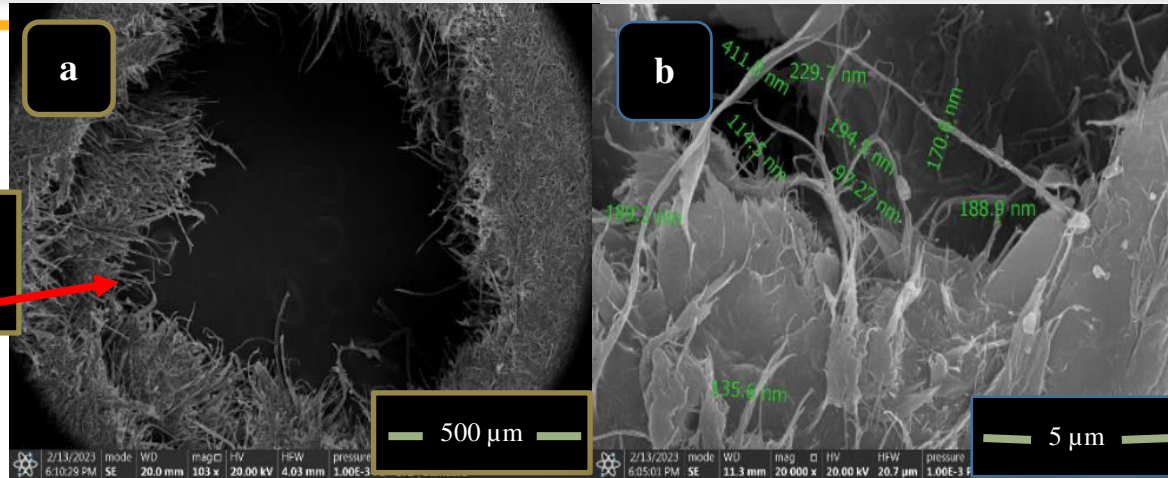


Burst test setup

Plot of Force vs distance of SMC& LVB Sheets

SEM images of Burst test samples

Ductile fracture



Brittle fracture

SEM images of Burst tested samples of SMC (a, b) and LVB (c, d) sheets

Gurley method (Porosity)

- **“Porosity”** measures the amount of time required for a certain volume of air to pass through a test specimen.



**LVB Sheet
(0.8mm)-a**

**SMC Sheet
(0.8 mm)-b**

**Commercial
fragmented
aluminium
coated Sheet
(0.1 mm)-c**

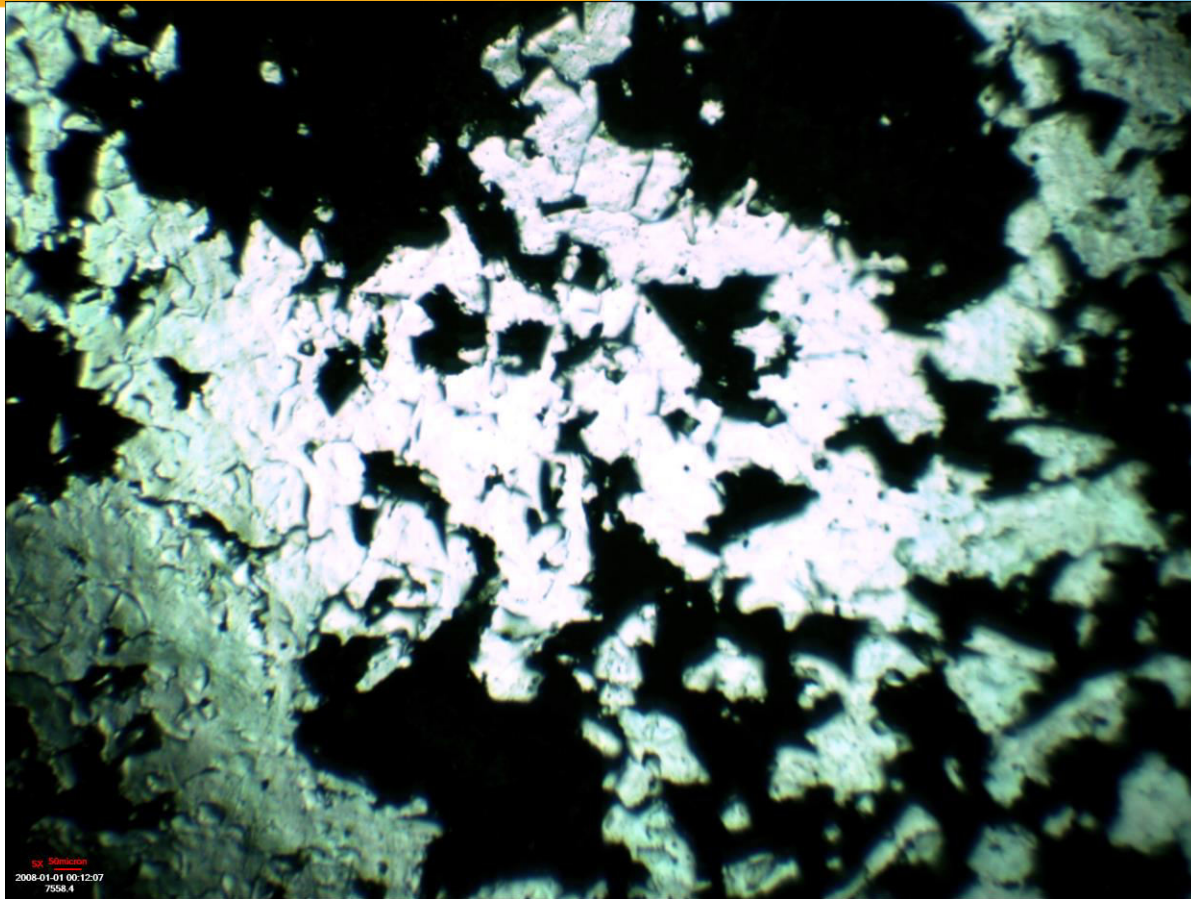
**Commercial
Green paper
plate (thin &
fragmented
plastic wrap
(0.25 mm)-d**

Porosity test results

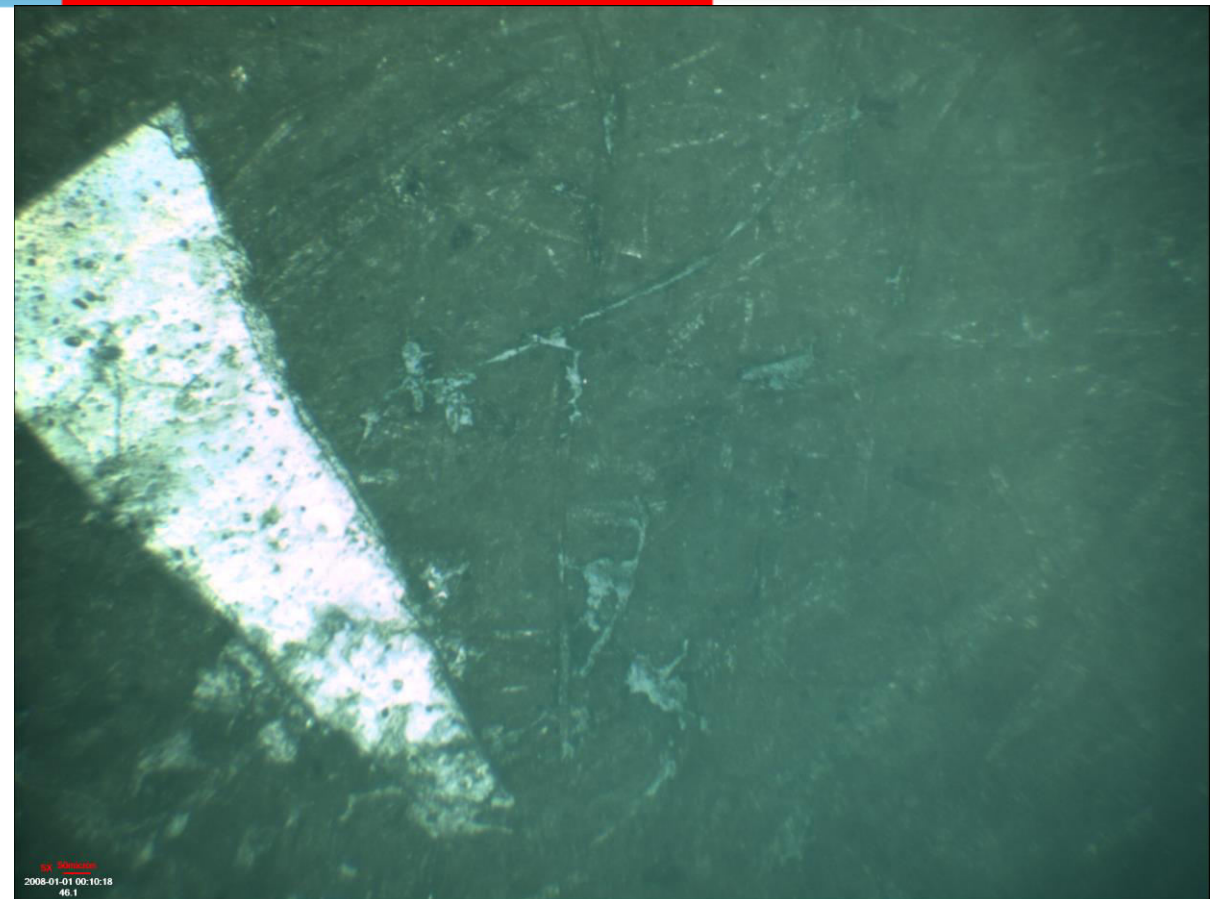
Time taken to pass the volume of air(ml) through a refined sheets and commercial paper plates

Refining (LVB/SMC)	Time (seconds)				
	100 (ml)	150 (ml)	200 (ml)	250 (ml)	300 (ml)
LVB_0_60 (0.8 mm thick)	10.30 ± 1.4	18.43±2.7	26.33±4.1	26.33±4.1	43.42±6.7
SMC_0_60 (0.8 mm thick)	14.72 ± 2.9	25.90±4.8	37.76±7.3	50.42±10	62.79±12.2
Al paper plate with partial coating (0.1 mm thick)	7.075±0.5	12.35±0.8	17.44±1.2	22.97±1.9	28.69±2.5
Green paper plate with fragmented plastic wrap (0.25 mm thick)	16.46±0.5	29.93±2.0	42.57±3.9	55.86±4.4	72.05±4.8

Microscopy images of Commercial paper plates

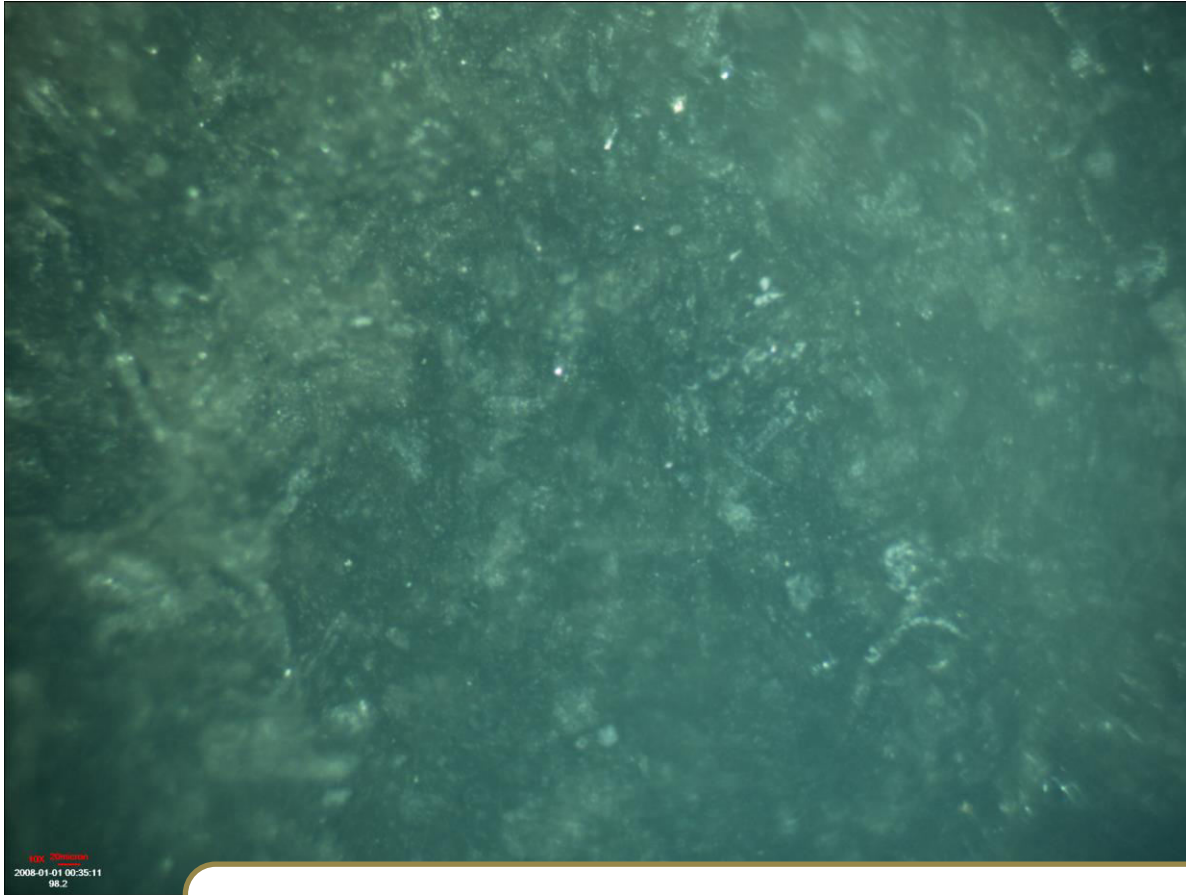


Fragmented aluminium coated paper plate (0.1 mm thickness)

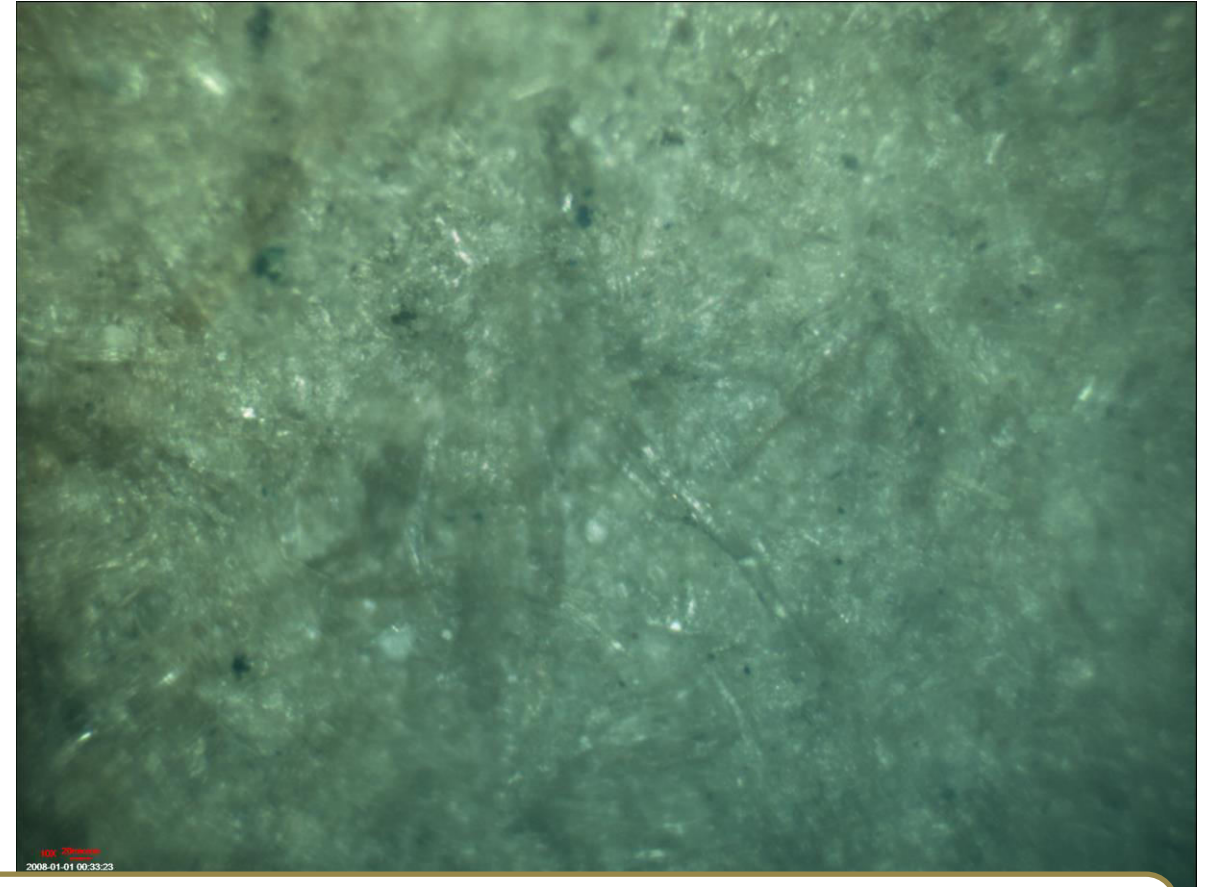


Fragmented plastic wrap based green paper plate (0.25 mm thickness)

Microscopy images of Porosity tested sheets



Lab Valley Beater refined Sheet;



Super Masscollider refined Sheet

Conclusion

- ❖ Super Masscolloider refining (SMC) resulted in more number of micro and nanocellulose fibres (60 - 260 nm) compared to Lab Valley Beater refining.
- ❖ By producing nanocellulose pulp fibers from the packaging like Amazon (using SMC refining) can eliminate the use of non-biodegradable plastic materials used in food packaging (currently used as thin wrap on surface of paper plates)

Paper Plates used commercially




amazon.in/CHUK-Baggase-Meal-Tray-Compartment/dp/B09FSS3TZF/ref=asc_df_B09FSS3TZF/?tag=googleshopdes-21&linkCode=df0&hvadid=5863

Nanocellulose can strengthen this sheet/plate

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