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Valorisation of municipal wastes through development of recovered sludge cellulose/biopolymer composites

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SMART-Plant

Research Programme

Circular economy in the water sector

- Water
- Biogas & Heat
- Nutrients
- Biopolymers
- Cellulose
- Others

Anaerobic Digestion

↑

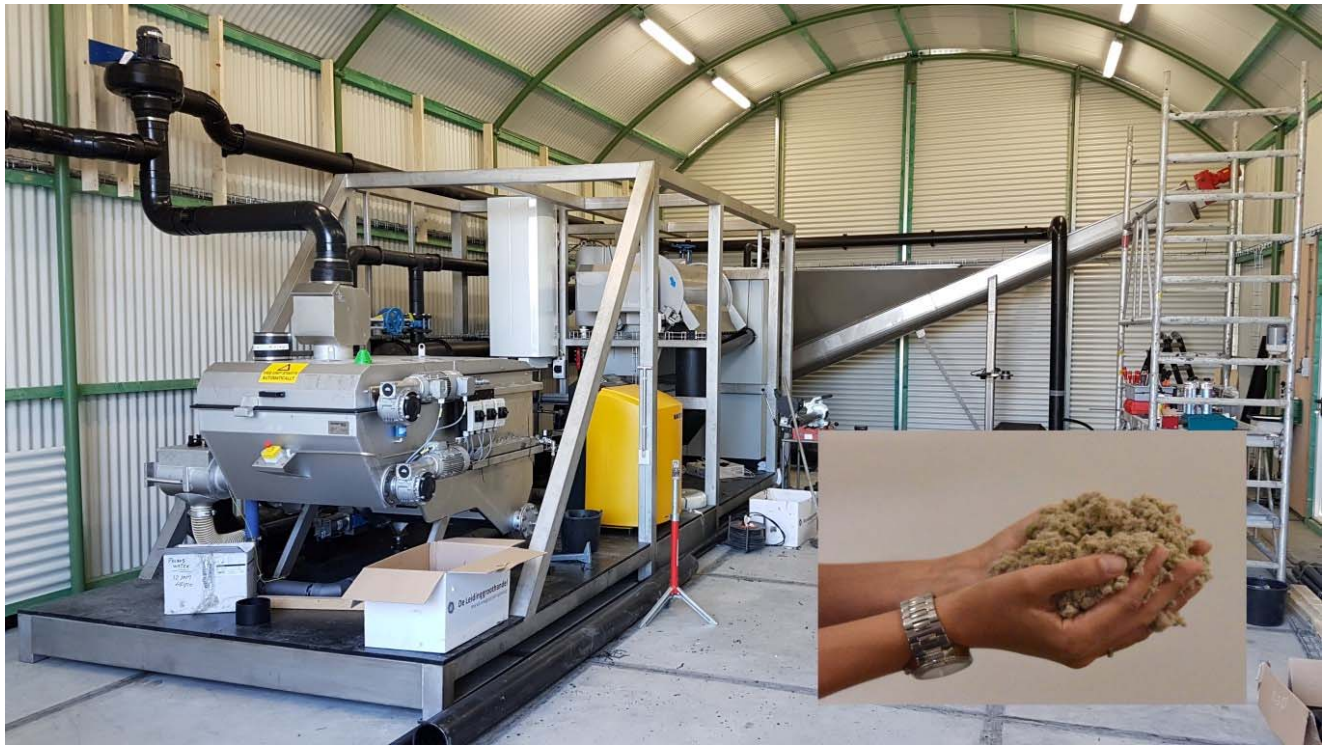
Sludge

In England and Wales, 80% of sewage sludge is currently treated through AD.

http://smart-plant.eu/

Cellulose Recovery

Coarse Screening → Grit Removal → Hairs & Organics Removal → Harvesting Cellulose → Drying and Pelletising



Cellulose Recovery

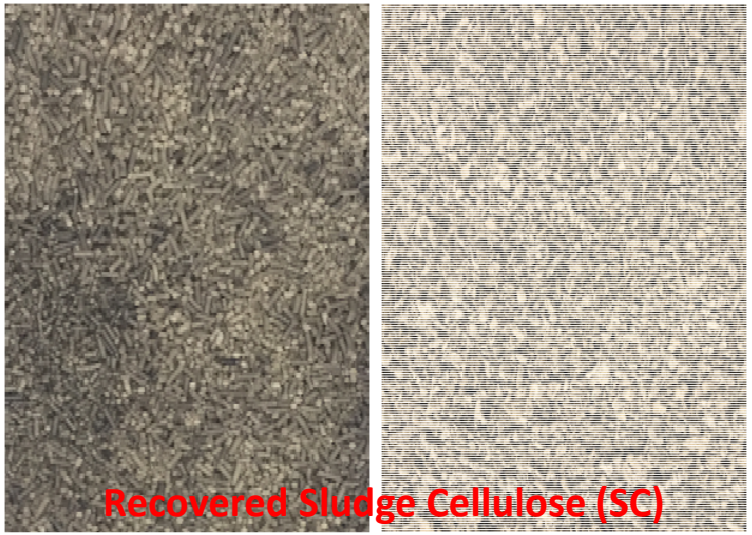
Coarse Screening → Grit Removal → Hairs & Organics Removal → Harvesting Cellulose → Drying and Pelletising

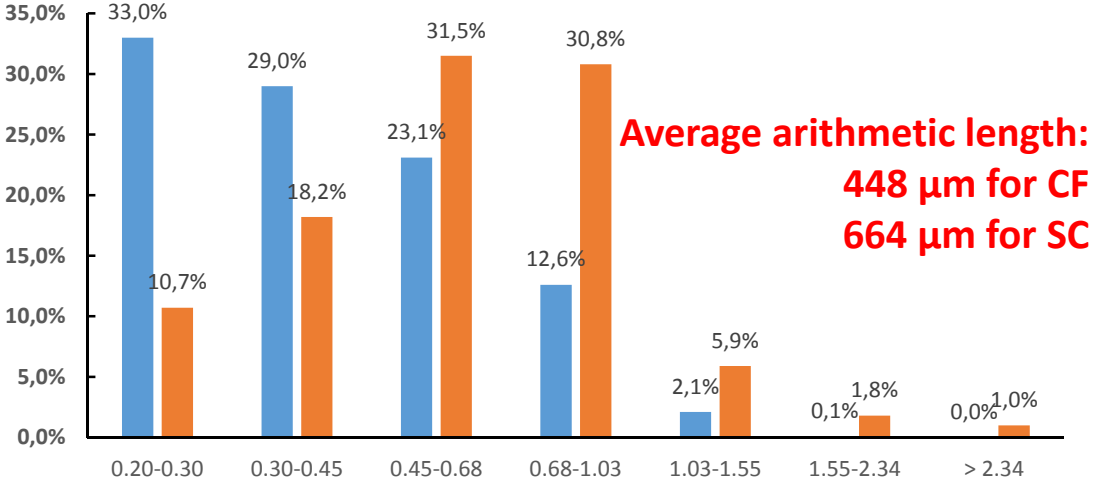
The size of ranges from mm, that rer large particles and towels.
30 to 80 m3/ is pumped int pilot plant aft screening.

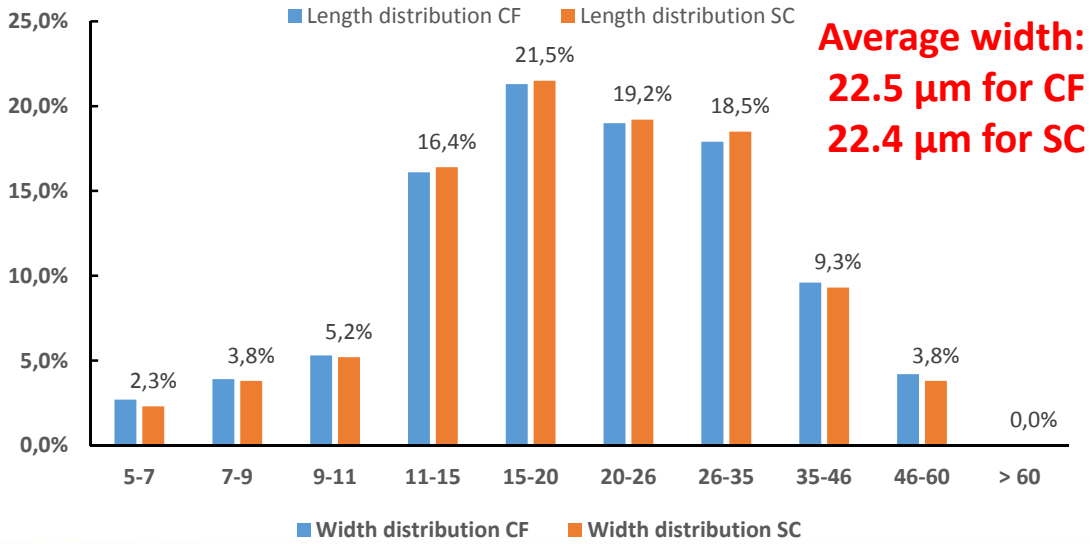
Grit-free waste water passes onto a rotary screen filter that removes the hairs and organic wastes with the particle size larger than 350 microns.
Rotary Screen:
Continuous running
Self-cleaning system
Automatic drive operation

CellCan rotating belt filter with a filter mesh of 350 microns removes the pre-coat particles upto 80 microns.
Automatically controlled belt speed
Low flux leads to a higher removal vice versa.

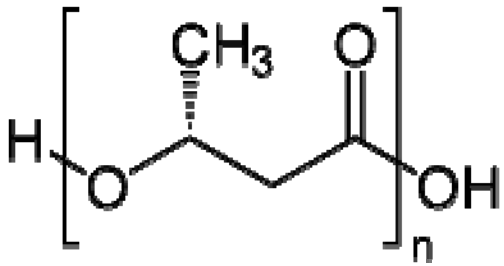
Cellulose Recovery

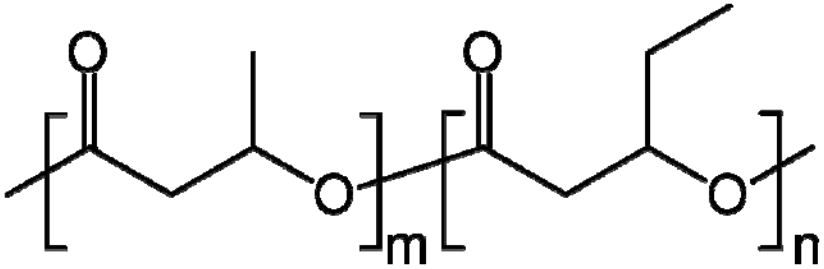




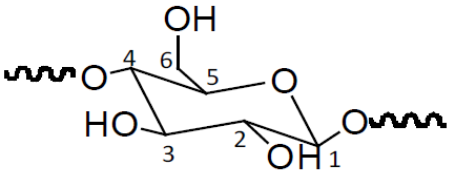


Composite Development

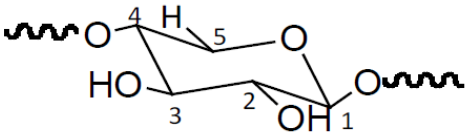




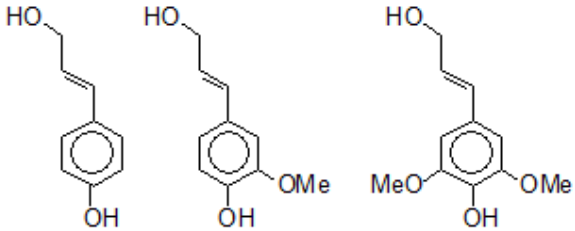
PHAs



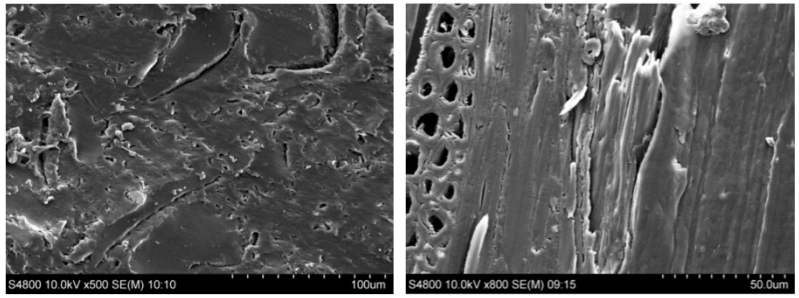
glucose



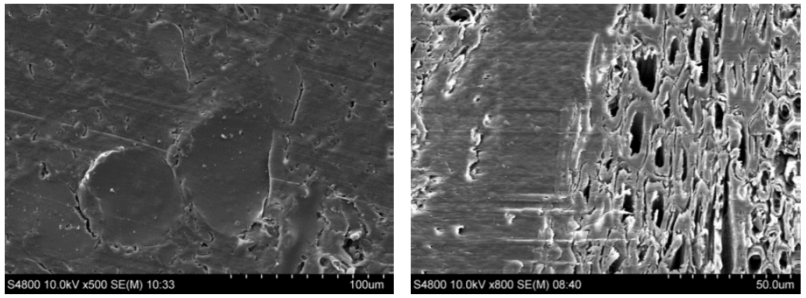
xylose



Phenyl propane monomers in lignin



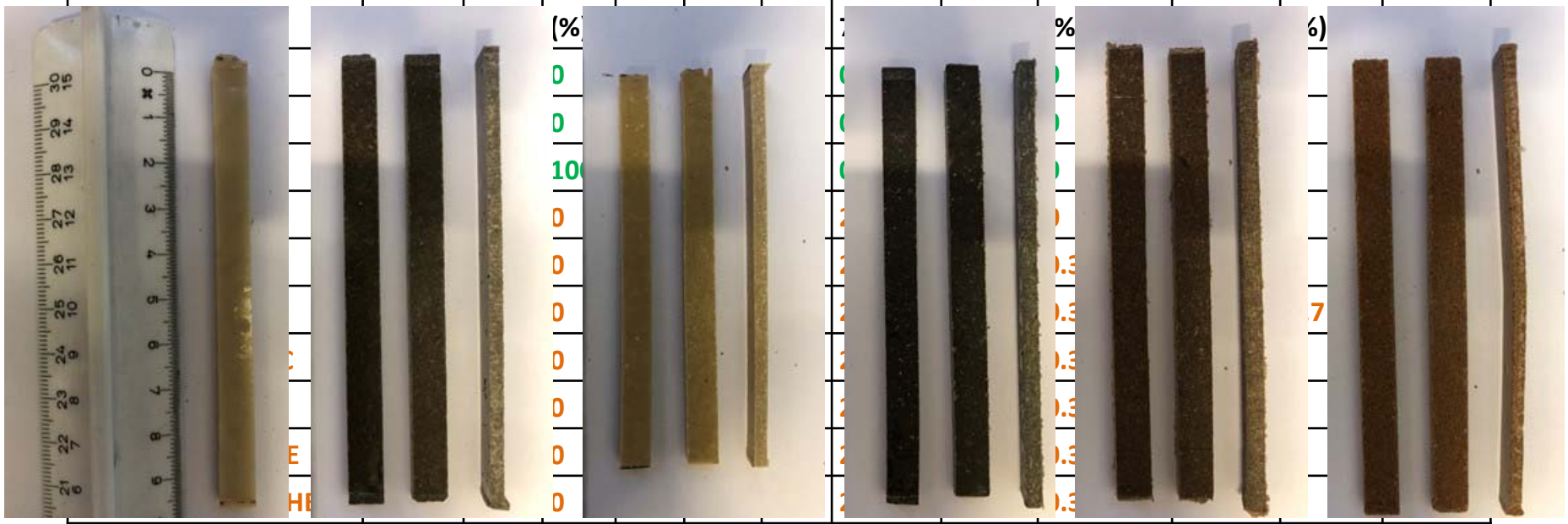
Incompatible components



Compatible components

Composite Development

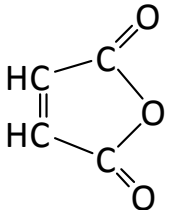
Composites	Polymer matrix			Cellulosic filler			Lubricant and Compatibiliser		Initiator	Coupling agent		
	PHBV	PE	PLA	SC	WF	CF	TPW	12HSA	Peroxide	MA (%)	APS	VTMS
Untreated CF-PHBV	55	0	0	0	0	40	2.5	2.5	0	0	0	0
MA treated CF-PHBV	52	0	0	0	0	40	2.5	2.5	0.3	2.7	0	0
APS treated CF-PHBV	52	0	0	0	0	40	2.5	2.5	0.3	0	2.7	0
VTMS treated CF-PHBV	52	0	0	0	0	40	2.5	2.5	0.3	0	0	2.7



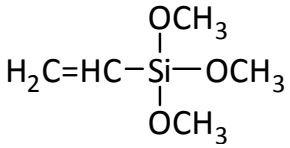
Composite Development

Matrix/Composite	Tensile stress (MPa)	Tensile strain (%)	Flexural stress (MPa)	Flexural extension (mm)
PHBV	26.06	2.46	64.62	8.46
PE	23.26	8.61	21.95	11.17
SPC (Untreated)	**5.81**	**0.31**	**3.73**	**0.25**
SPC (MA treated)	**10.17**	**0.45**	**8.65**	**0.40**
SPC (VTMS treated)	**9.55**	**0.45**	**9.54**	**0.39**
SC-PE	13.58	1.69	23.91	3.80
WPC	17.15	2.48	24.80	3.40
WF-PHBV	8.40	0.37	4.25	0.13
CF-PHBV	15.73	0.67	16.40	0.65

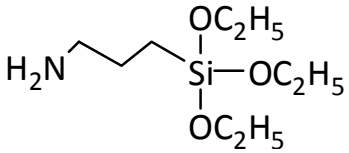
Composite Development



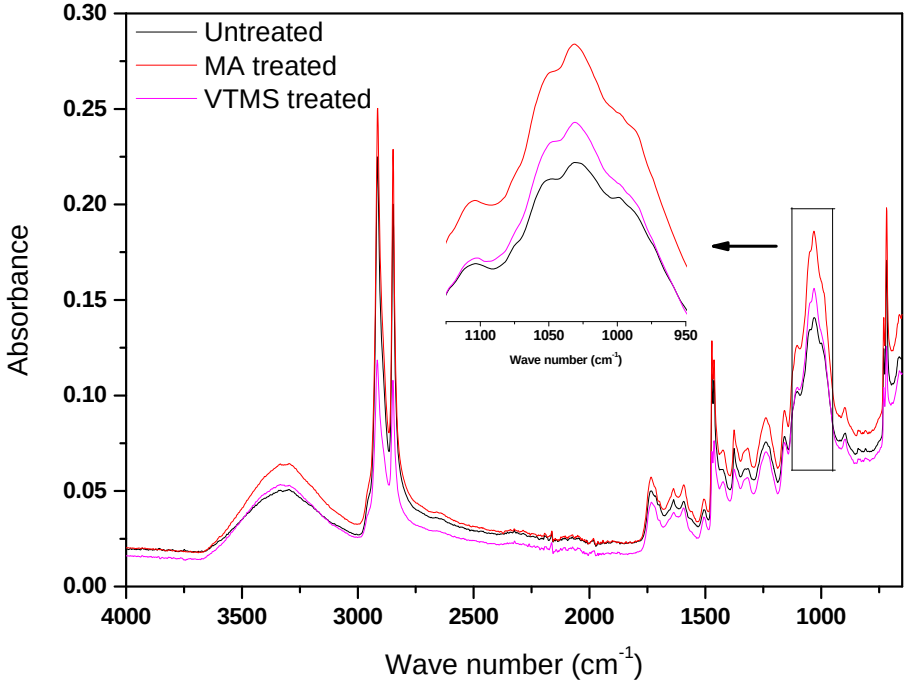
Maleic Anhydride (MA)

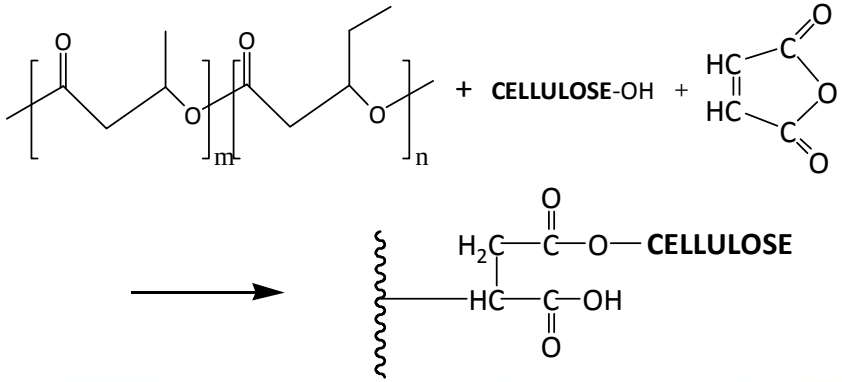


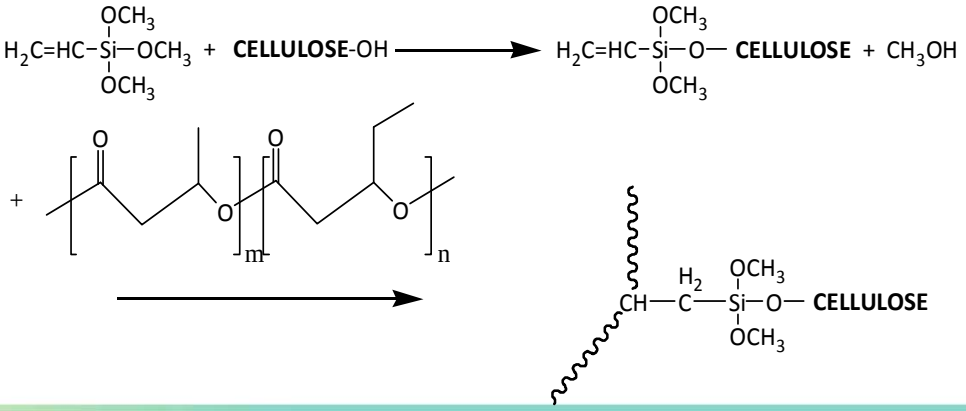
Vinyltrimethoxysilane (VTMS)



γ-aminopropyltriethoxy silane (APS)

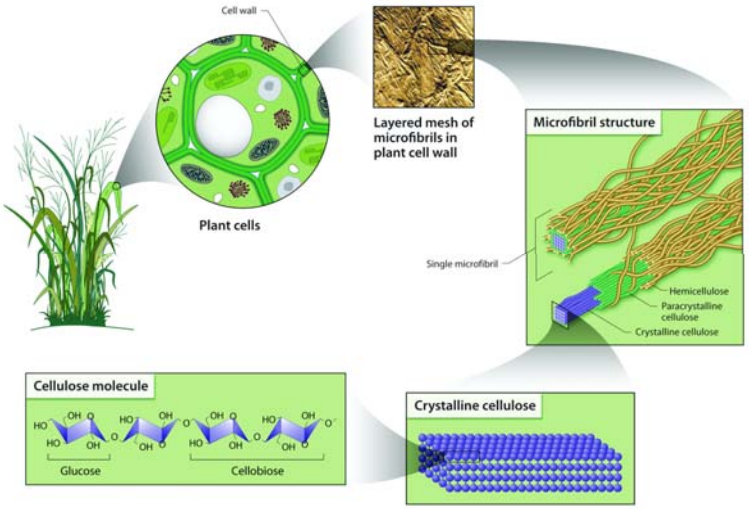




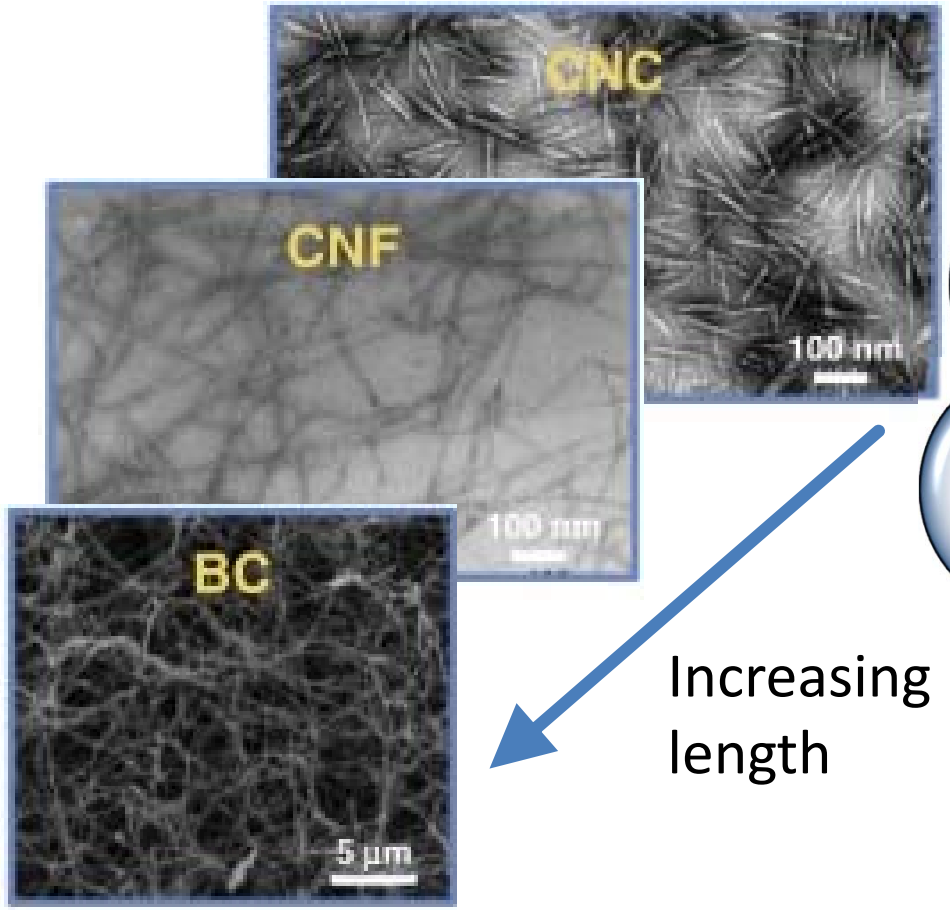


Nanofillers - Nanocellulose

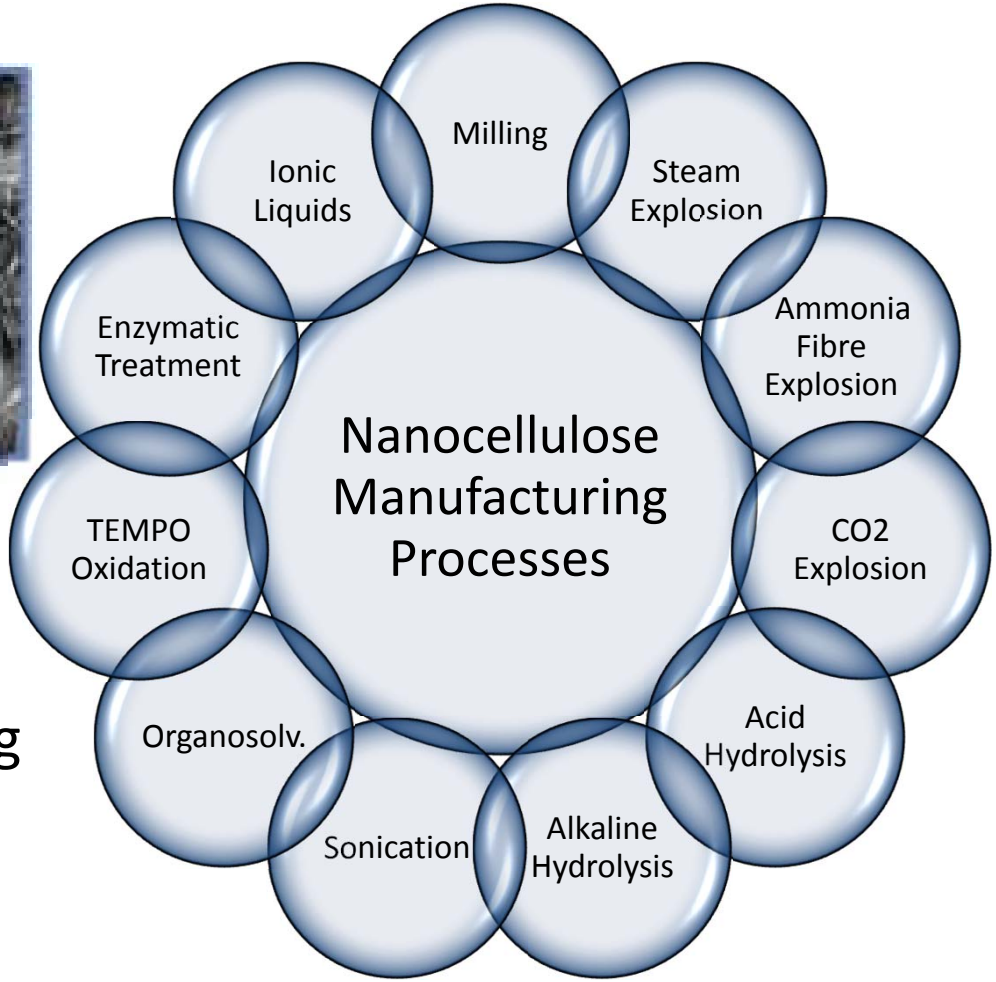
- Elementary unit of crystalline cellulose – typical dimension of 5 nm x 20-200 nm
- Opportunity for chemical modification (surface -OH) – Complimentary
- **Light weight** material, builds network structures
- **Renewable** resource, **Biocompatible** & **Biodegradable**
- **High stiffness** (5-45GPa) & **strength** (3-800MPa)
- High water binding capability
- High Surface Area
- Optical properties
- Self-assembly



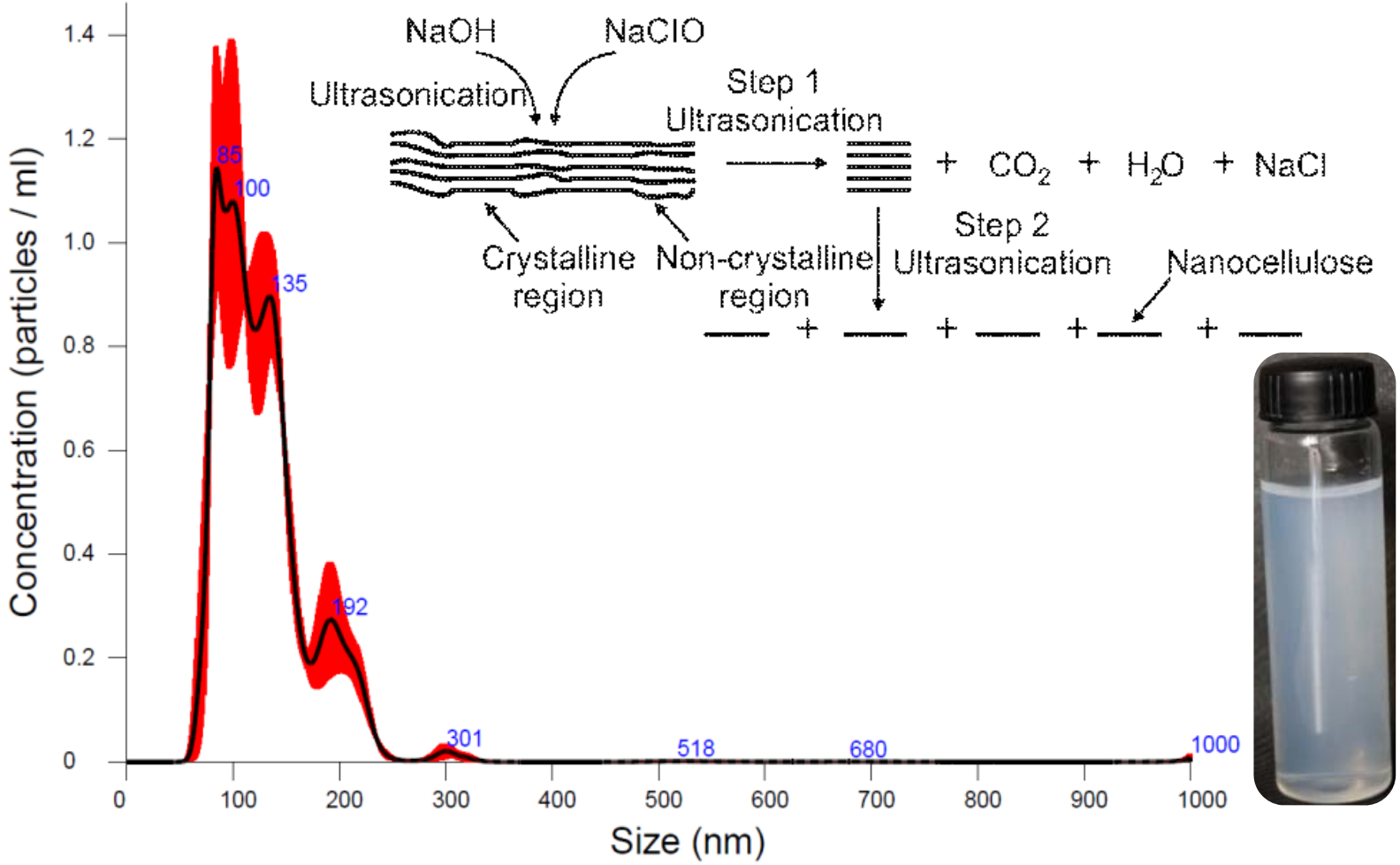
Nanofillers - Nanocellulose



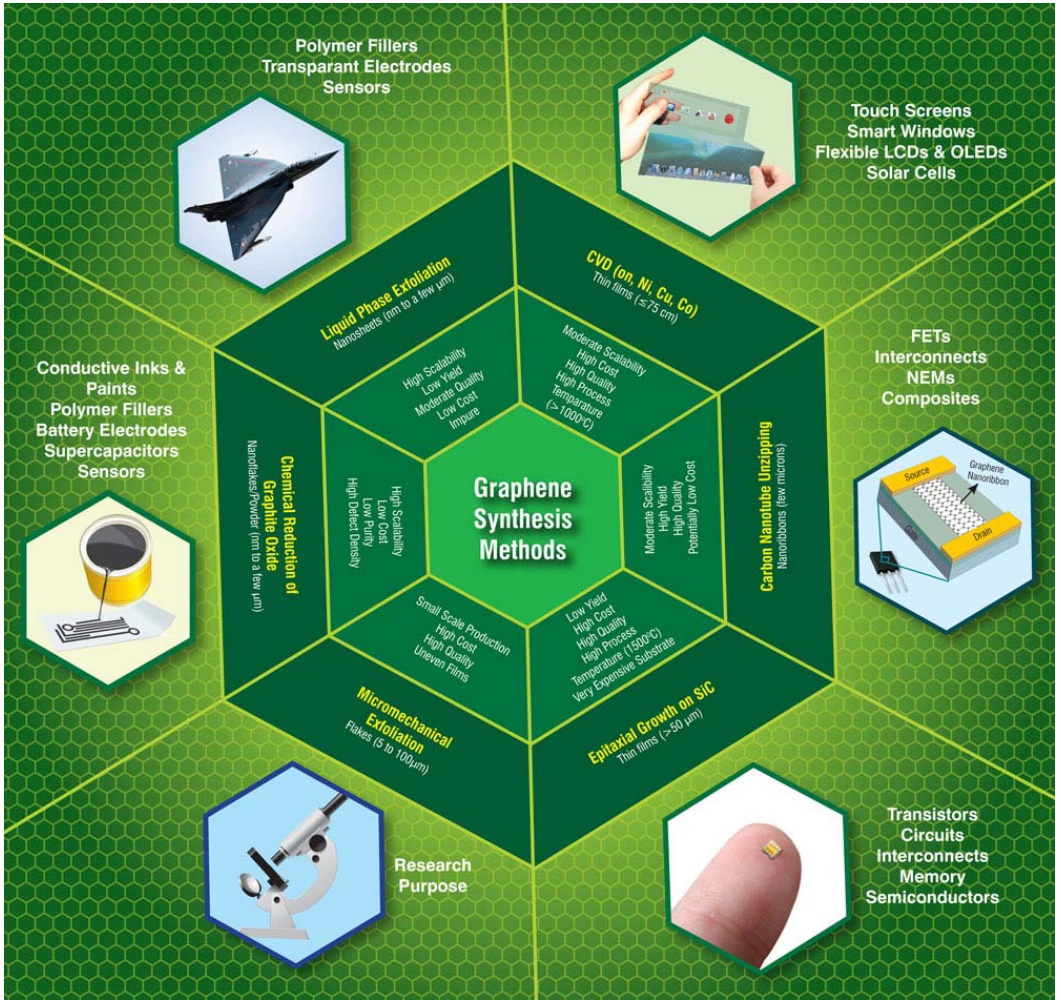
Increasing length

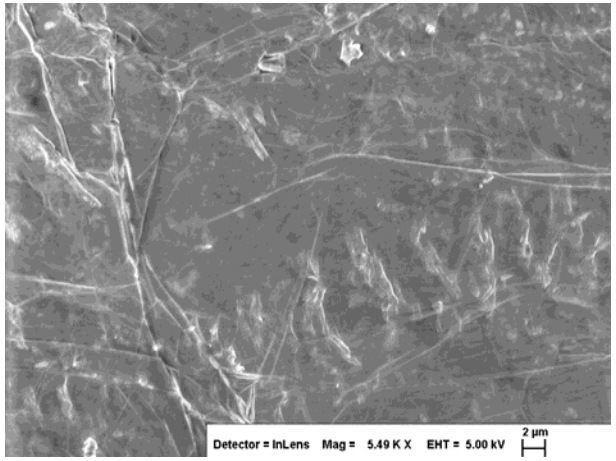


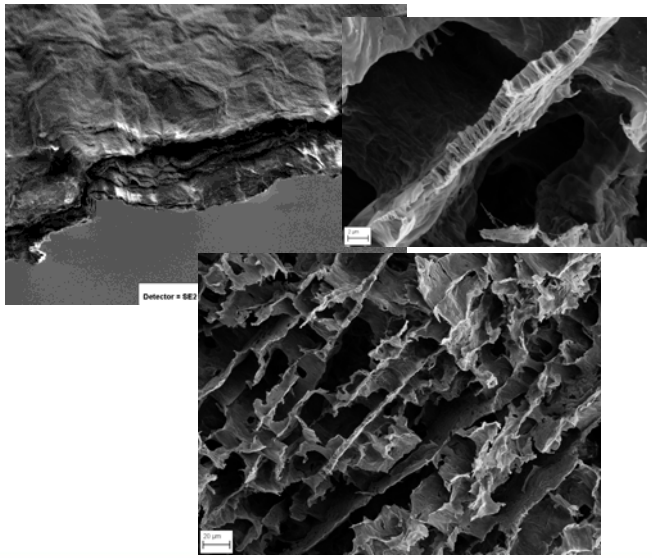
Nanofillers - Nanocellulose



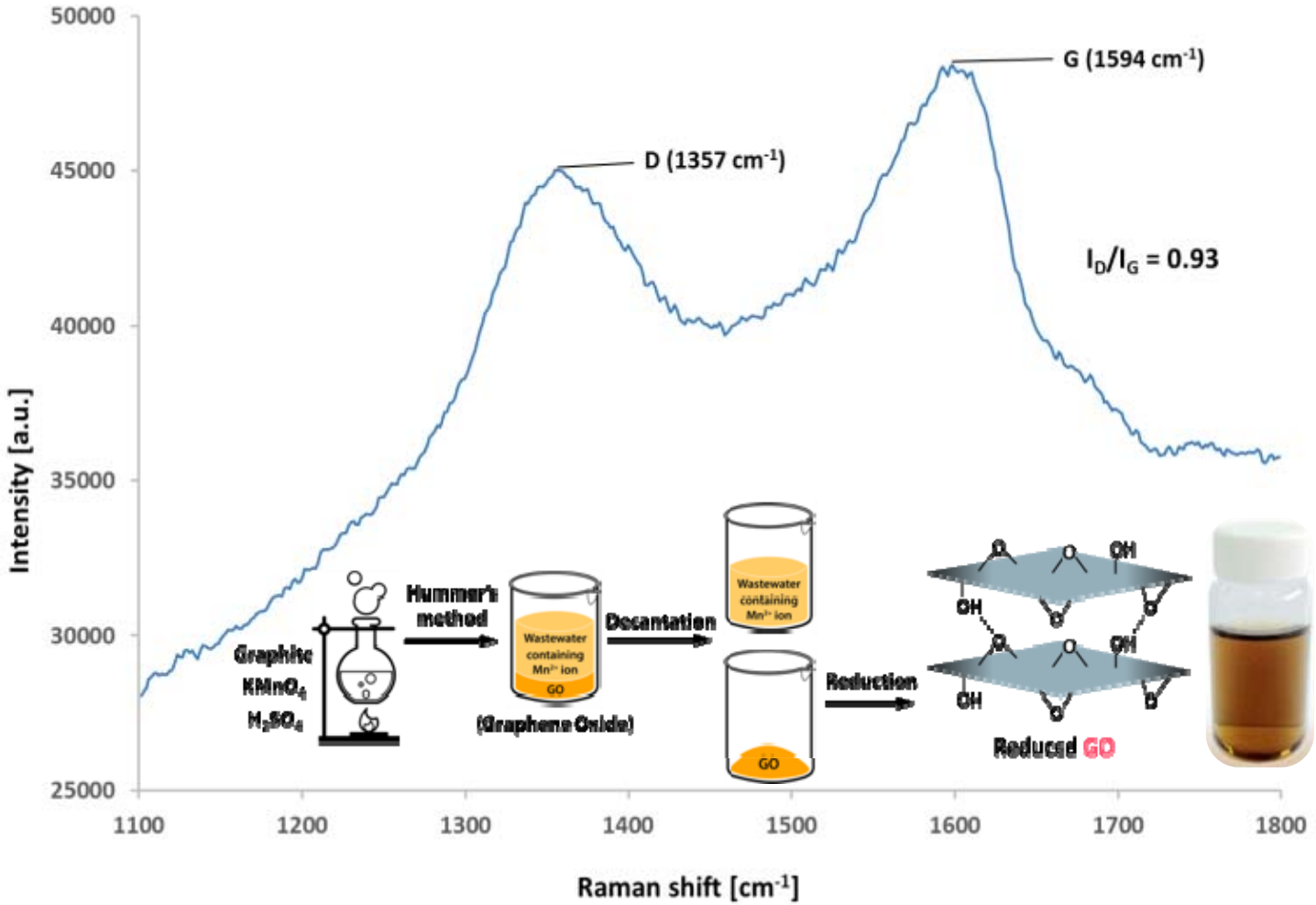
Nanofillers - Graphene







Nanofillers – Graphene Oxide (GO)



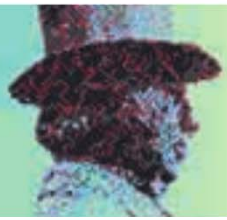
Thank you very much for your kind attention!

Q/A

http://smart-plant.eu/

https://www.brunel.ac.uk/civil-engineering

Brunel University London



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