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CELISE Mid-Term Meeting

WP1: Biomass processing

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Latvijas Valsts Koksnes Ķīmijas Institūts

Latvian State Institute of Wood Chemistry– LS-IWC

24th July, 2023





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Objectives

- Transfer of knowledge about sustainable lignocellulosic processing
 - To obtain cellulose pulp, biochar and fibres from biomass residues. In addition, energy production in rural areas obtained from the rest of fractions (lignin, hemicellulose) will be also studied.
 - The best characterisation methods will be also analysed.
 - In addition, two workshops about pretreatment methods and novel fibre production in SMEs and applications will be carried out, mainly for younger researchers.
- Create knowledge about
 - (i) novel characterisation methods of lignocellulosic materials by HPLC and FTIR;
 - (ii) novel hydrolysis and biochar production processes using deep eutectic solvents and hydrothermal processes;
 - (iii) joining processes for second-generation of ethanol production; and
 - (iv) new fibre bio-products from cellulose materials and natural additives.
- Skill development for biomass processing and characterisation in SMEs and rural areas.



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Tasks and secondments done

- Task 1.1. Characterisation methods and residues.

(Leading by LS-IWC) **M03-M11**

Secondments related to this task:

Oskars Bikovens from LS-IWC to UCC

Juan Carlos Colmenares from IChF to UCC

Jakub Klaban from Inocure to LSIWC

Alberto Coz from UC to Inocure

Tamara Llano from UC to Inocure

Rodrigo Leonardi from FICH-UNL to UC

Tamara Llano from UC to FICH-UNL

Summary of tasks:

- Waste materials: (i) cocoa production waste (cocoa pod husk, mucilage and bean shell, cocoa tree pruning) available in rural and vulnerable areas, (ii) coffee production waste (coffee pod husk, mucilage, and bean shell, coffee silverskin) available in rural and vulnerable areas, (iii) brewer spent grains from small enterprises, (iv) waste from corn in rural areas, (v) waste from soya in rural areas.
- Best characterisation methods: a summary of all of them is presented in D1.1



Tasks and secondments done

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Samples by F. Colmenares, Universidad Cooperativa de Colombia and J.C. Colmenares, Poland



Cocoa wastes



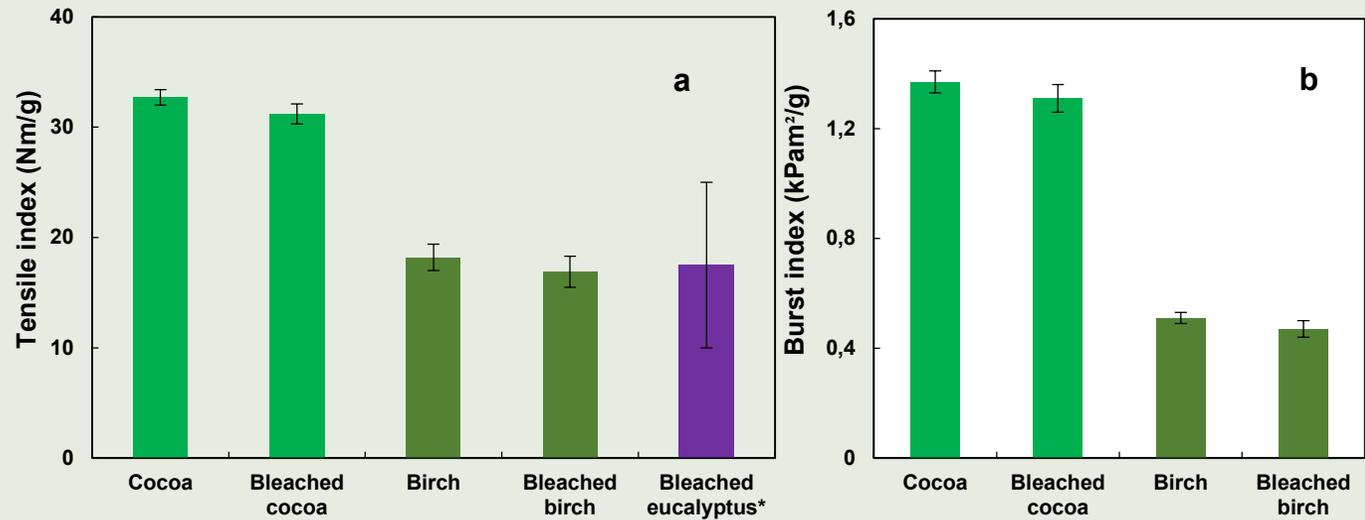
Coffee wastes



Tasks and secondments done

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Kraft pulp of Cocoa branches compared with traditional pulp wood in paper industry





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Tasks and secondments done

- **Task 1.2. Novel and sustainable hydrolysis processes as pre-treatment.**
(Leading by UC) **M03-M17**

Secondments related to this task:

Carlos Burgos from UNACH to UC 2022

Alberto Coz from UC to FICH-UNL

Jakub Klaban from Inocure to LSIWC

Alberto Coz from UC to Inocure

Tamara Llano from UC to Inocure

Rodrigo Leonardi from FICH-UNL to UC

Tamara Llano from UC to FICH-UNL

Summary of tasks:

- Acid hydrolysis
- Alkaline hydrolysis
- Deep eutectic solvents
- Autohydrolysis
- Steam explosion (SE) autohydrolysis
- **Techno-economical evaluation of methods**



Tasks and secondments done

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- Integrated biorefinery for the valorization of wastes
- Mild acid, autohydrolysis and organosolv pretreatment towards the isolation of biomass components (cellulose, hemicellulose, lignin)
- Production of nanocellulose and valorization of hemicellulose and lignin streams



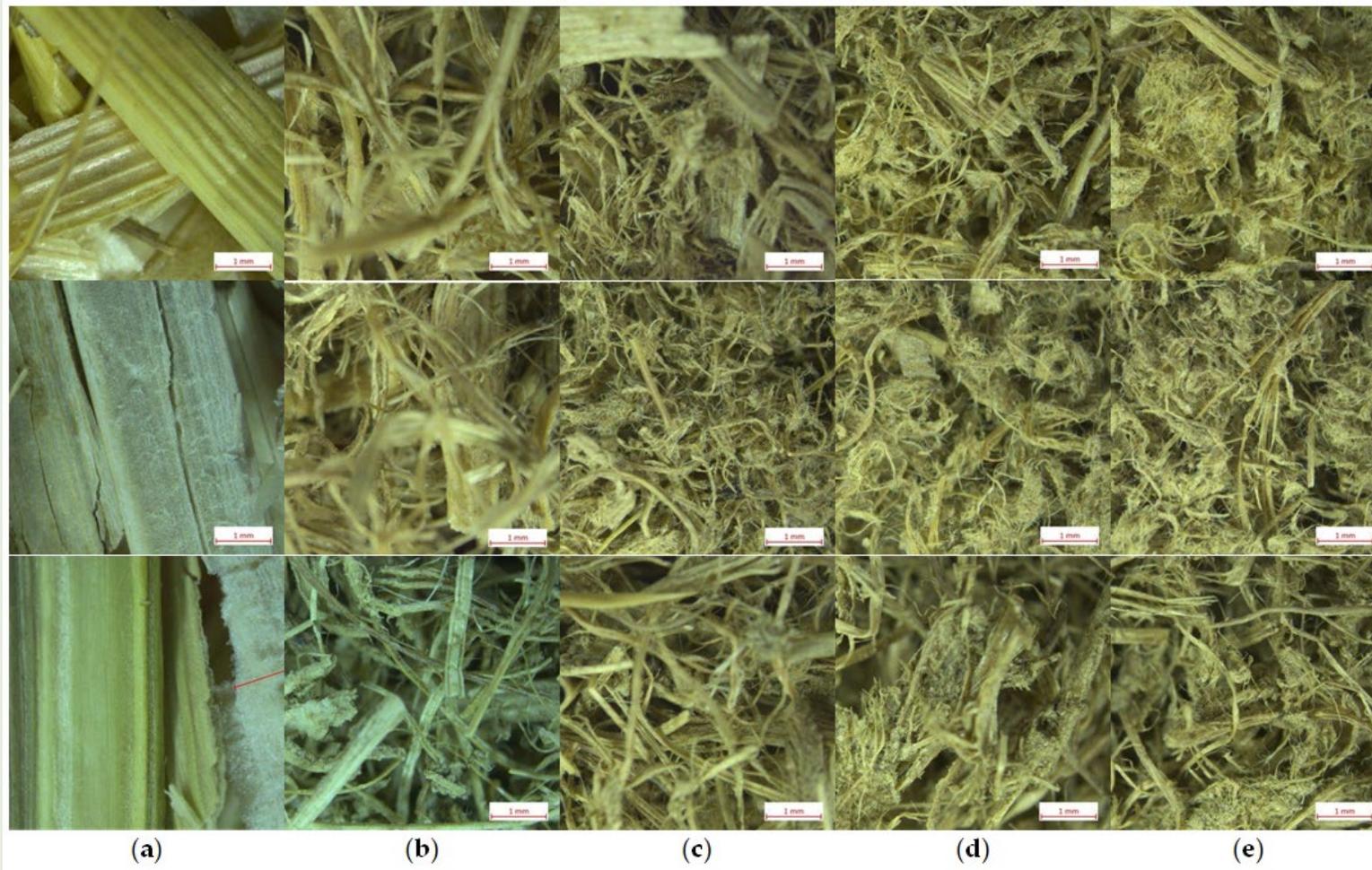
24/07/2023

CELISE 2023 Mid-term meeting



Tasks and secondments done

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Microscopica I surface view (0.63 \times , scale bars 1 mm) of wheat straw (**above**), reed (**middle**) and corn stalk samples (**bottom**): (a) Raw and steam-exploded at 230 °C after (b) 15 s, (c) 30 s, (d) 40 s and (e) 50 s.



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Tasks and secondments done

- Task 1.3. Energy production in rural areas.

(Leading by SGGW) M04-M23

Secondments related to this task:

Fernando Colmenares from UCC to UC

Alberto Coz from UC to FICH-UNL

Rodrigo Leonardi from FICH-UNL to UC

Summary of tasks:

- To study fermentation process for lignocellulose materials
- To study energy demand and biomass energy production possibilities in rural areas.
- To study the production of bioethanol from waste biomass



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Tasks and secondments done

- Task 1.4. Production of biochar and applications.

(Leading by LUT) **M08-M24**

Secondments related to this task:

Juan Carlos Colmenares from IChF to UCC

Summary of tasks:

- Carbon-based materials from coffee residues
- Slow pyrolysis from coffee residues (A collaboration between WUT and UC).



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Tasks and secondments done

- Task 1.4. Production of biochar and applications.

(Leading by LUT) **M08-M24**

Secondments related to this task:

[Juan Carlos Colmenares from IChF to UCC](#)

Summary of tasks:

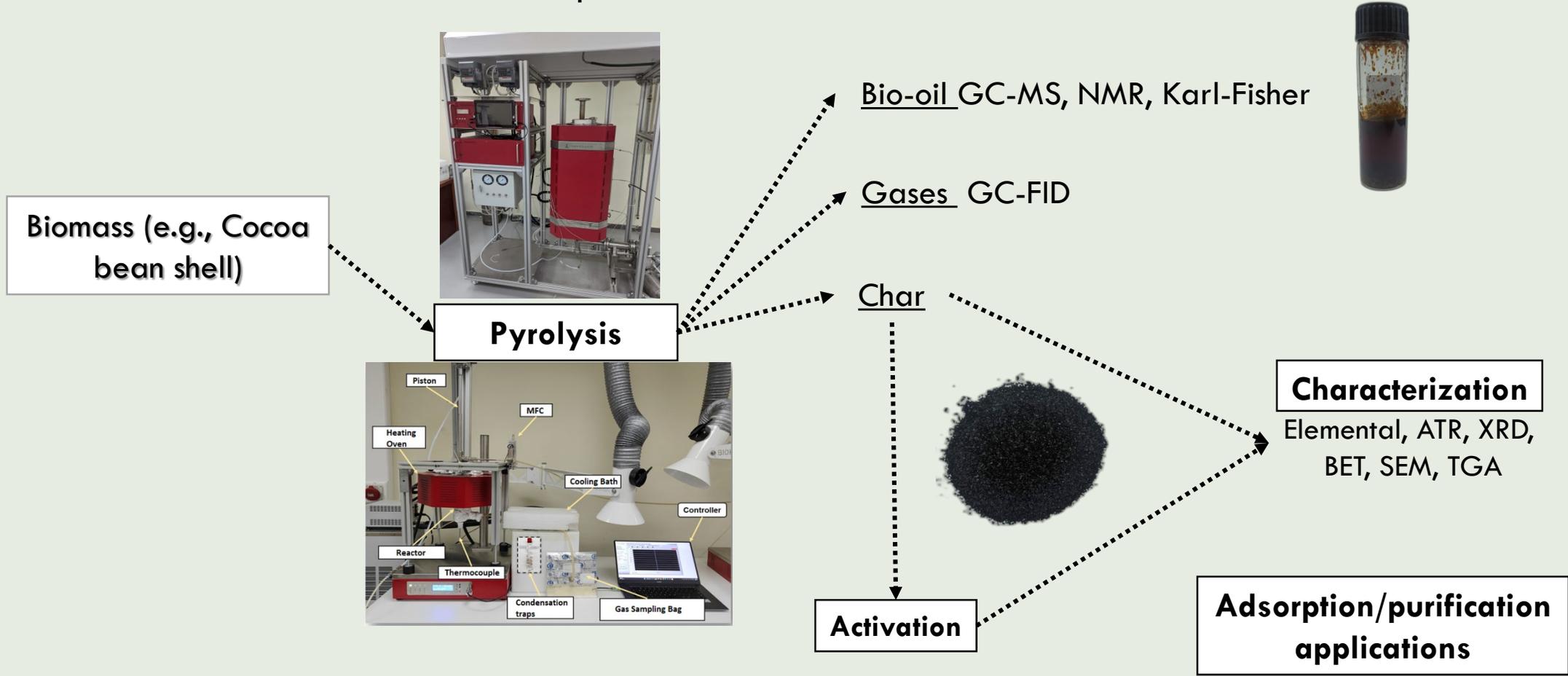
- Carbon-based materials from coffee residues
- Slow pyrolysis from coffee residues (A collaboration between WUT and UC).



Tasks and secondments done

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- AUTH is involved in the biomass/waste pyrolysis, towards value added products, using a fixed bed lab scale reactor and micro pilot unit





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Tasks and secondments done

- Task 1.5. Production of fibres and applications.

(Leading by INOCURE) M08-M39

Secondments related to this task:

Oskars Bikovens from LS-IWC to UCC

Juan Carlos Colmenares from IChF to UCC

Muhammad Yasir from Inocure to UC

Velta Fridrihsone from LS-IWC to Inocure

Dominika Hanusova from Inocure to LS-IWC

Alberto Coz from UC to Inocure

Tamara Llano from UC to Inocure

Kim Standfield from VoCATE to UCC

Summary of tasks:

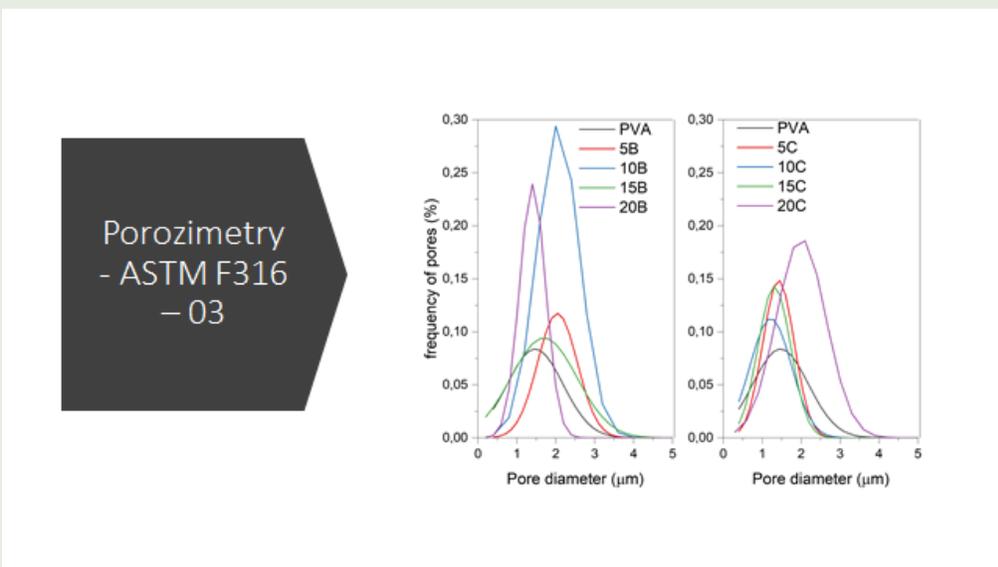
- Lignin fibers from coffee waste for carbon-based materials and new aromatic-based intermediates (biofarmacy)
- Nanocellulose from lignocellulosic biomass (cocoa tree pruning) to be used for treatment of emerging contaminants by electrospinning
- Use of coffee silverskin fibers as pre-treatment of protein samples for nanofibers biosensors.
- Modified nanocellulose obtained by microfluidizer incorporation into a PVA or PLA polymer matrix by electrospinning.
- Evaluation of the nanocellulose influence on parameters of obtained polymer material. Microscopic characterization of samples.
- To study the stakeholders needs for technology commercialisation based on QFD (Quality Function Deployment) and Design Thinking approaches.



Tasks and secondments done

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Electrospun PVA, PUEL, PLA samples with CNF



RRB 2023
Research Report

Compatibility of ammonium persulfate oxidized nanocellulose with electrospun polymers for filtration materials

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 †Centre of Polymer Systems, Tomas Bata University in Zlín, Zlín, Czech Republic
 ‡NOOCURE, Prague, Czech Republic
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Introduction
 Purpose of this research was to explore compatibility of ammonium persulfate oxidized cellulose nanofibers (APS-CNF) with various commonly electrospun polymers and to investigate appropriate spinning parameters for materials with potential application for filter materials.
 Poly(vinyl alcohol) (PVA), Polyurethane elastomer (PUEL), Poly(lactic acid) (PLA) and Polyamide 6 (PA6) were chosen for the research. APS-CNF were obtained via oxidation of cellulose fibres with APS and mechanical treatment. APS-CNF was used as 5% water dispersion. Investigation included adjustment of concentration of polymer's solutions, concentration of APS-CNF and adjustment of spinning parameters for SpinJet 40 (SPJ40, Czech Republic). Spinning was realised on slide on polypropylene spin-bands as fibre collecting substrate. Conductivity of solutions were determined before the spinning process, and spun materials were investigated by scanning electron microscope (SEM).

Experimental
 It was found that the best concentrations for spinning were 14% and 16% for PVA, 15% and 20% for PUEL, 8% for PLA and 19% for PA6, while the most appropriate range of APS-CNF in polymer solutions was 0.010 - 0.045g of CNF per 1 g of polymer. For PVA/APS-CNF solution the conductivity was found to be around 300 µS/cm and none of compatibility problems were identified. Investigated spun fibres were various sizes and overlapping fibres were stuck together enough for retained electrospun material to have filtration potential. PUEL and PLA solutions were identified as incompatible with CNF because of the polarity. The obstruction was overcome by addition of tetrahydrofuran. Low conductivity of solution was detected and was increased by addition of citric acid/borax unit conductivity 100 µS/cm. For PA6 / APS-CNF solution the conductivity was increased, however compatibility of polymer with APS-CNF dispersion was better than in the case of PUEL and PLA.

25% PUEL 2g APS-CNF
 18% PUEL 2g APS-CNF
 16% PLA 2g APS-CNF
 19% PA6 2g APS-CNF

16% PVA 2g APS-CNF
 14% PVA 2g APS-CNF
 14% PVA 2g APS-CNF (jets)
 14% PVA 2g APS-CNF (cords)

Conclusions
 Differentiation in the characteristics, such as fibre breakage, branching, thickness differences, deformations of investigated spun fibre samples was explored by SEM. It was concluded that PVA, PUEL, PLA and PA6 polymers with APS-CNF additive can be used for electrospun materials with potential application for filter materials.

Acknowledgments
 This research was funded by the Latvian State Institute of Wood Chemistry Bio-economic grant "WoodSpiter" and supported by EU H2020 MSCA-IFSE CELISE, grant agreement No 10107731.



Deliverables, Milestones and deadlines

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Number	Title	Beneficiary	Type	Dissemination level	Deadline
D1.1	Recommendations about characterisation methods in lignocellulose biomass	LS-IWC	Report	Public	M11
D1.2	Pre-treatments of lignocellulosic residues to be used in SMEs and rural areas	UC	Report	Public	M17
D1.3	Production of cellulose fibres, biochar, biofuels and energy to be used in SMEs and rural areas	SGGW	Report	Public	M39

Number	Title	Beneficiary	Deadline
MS1	Fibre material prototypes	BANGOR	M39



Deliverables, Milestones and deadlines

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D1.1. Recommendations about characterisation methods in lignocellulose biomass

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Future work

- **First workshop about biomass pretreatment methods**
 - Online: 29th September
 - Organised by AUTH and Ecoresources
- **Completion of deliverable D1.2.**
- **Increase the open access publications for next year**
- **Next secondments in this WP:**
 - SGGW to FICH-UNL, and to UCC
 - LSIWC to UCC
 - BANGOR to FICH-UNL, and to UCC
 - AUTH to CCC, and to UCC
 - TWI to AUTH
 - Ecoresource to UC
 - UNACH to UC
 - Latitud to UC
 - FICH-UNL to UC