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Extractives and nanocellulose

Innovative products from woody biomass

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CELCYCLE
Discarded potentials of biomass

The outline and objective

- To demonstrate expertise of UL-BF in the field of non-timber products form wood
  - Extractives
  - Nanocellulose

- To highlight education structure in the field of forest wood chain in Slovenia

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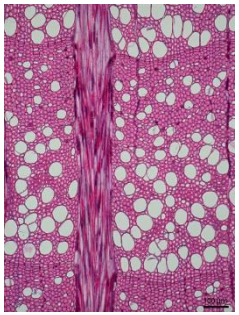
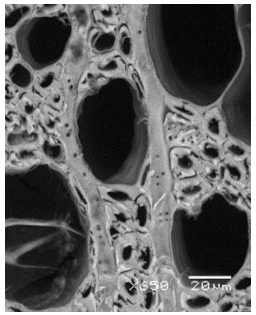
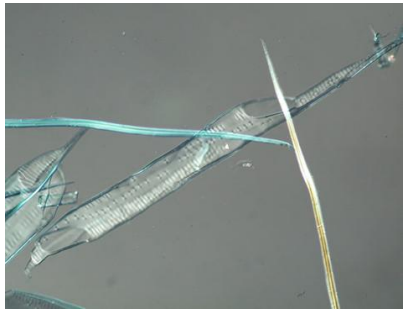
Wood is hierarchically organized polymeric composite

- Wood is build up from cells
- Cells have rigid cell wall



- Structural polymers of the cell walls
  - Cellulose
  - Hemicelluloses
  - Lignin
- Nonstructural compounds
  - Extractives

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Potential raw material of high added value products

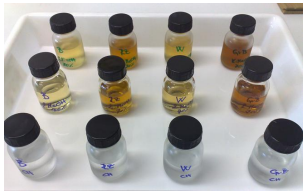
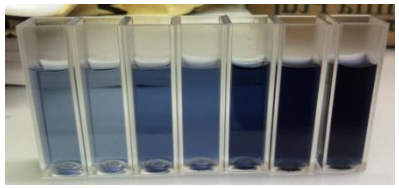
- Wood of low quality (wind, ice storm etc.)
- Wood of trees affected by insects (bark beetles etc.)
- Residues of forestry operations (branches, bark, tree tops)
- Residues of wood and paper industry
- Green pruning residues in the cities
- Municipal ligno-cellulosic residues etc.



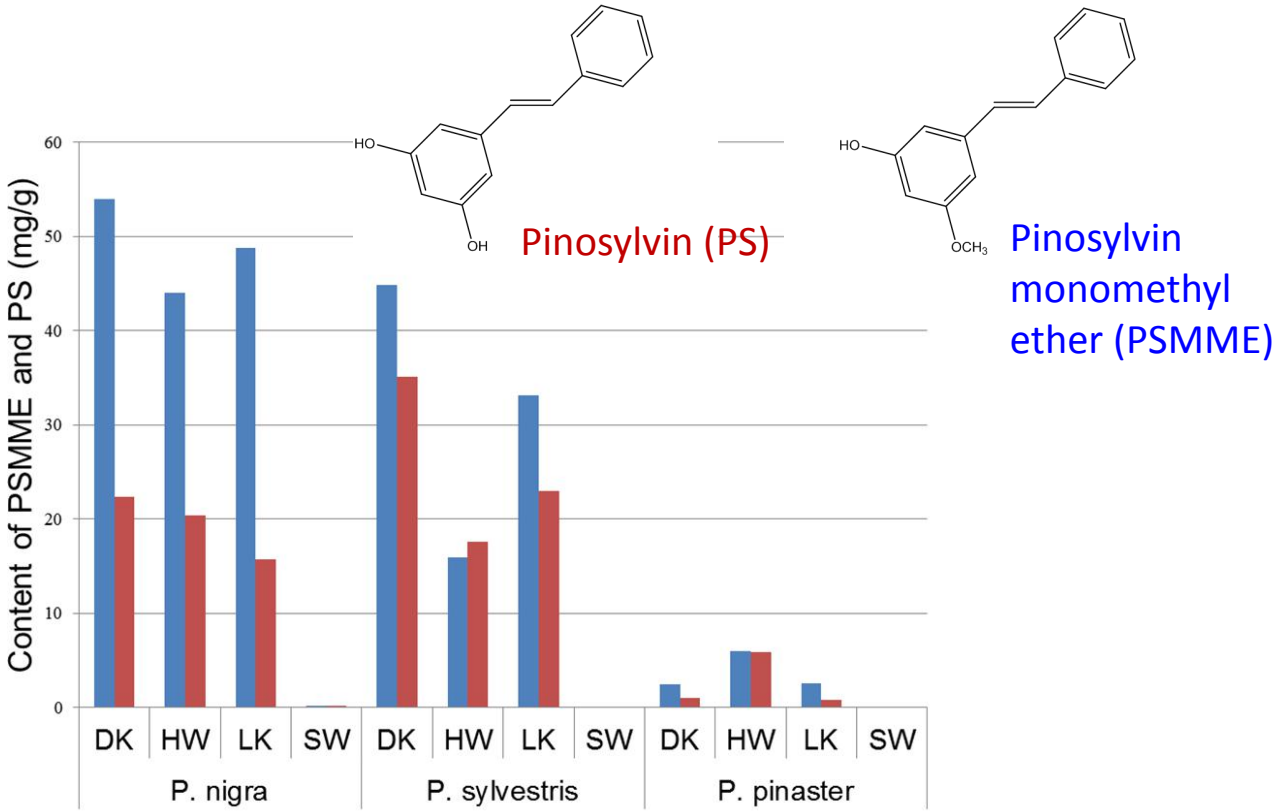


Wood/bark extractives

- Identification of reach botanical source of extractives
- Selection and preparation of material
- Separation, identification, isolation, purification of compounds
- Testing of biological activity of compounds (fungicidal, antibacterial, anti-oxidative properties
- Application of pure compounds or extractives (wood protection, biopolymers functionalization, food aplications etc.)


Pinosylvins in wood of pines



Extracts of pine knots have antimicrobial activity against Listeria and Candida. However, only PS had effect against Salmonella.

Nanocellulose

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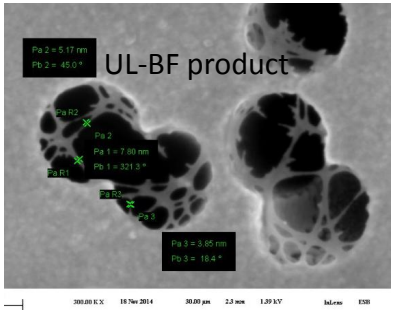
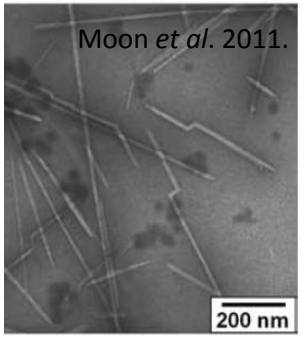
- NC is a type of nanostructured natural material obtained from wood or any other source containing cellulose
- Nanocellulose can be classified in two object types

Type of NC material		Size
Cellulose nanofibrils or nanofibrillated cellulose (NFC)		Diameter: 5 – 60 nm Lenght: > 1 μm
Cellulose nancrystals or nanocrystaline cellulose		Diameter: 5 – 70 nm Lenght: 100 – 250 nm

- Properties of NC:
  - Renewability and sustainability
  - Biodegradability
  - Good mechanical properties (E modulus~ 150 Gpa)
  - Broad chemical modifying capacity
  - Low thermal expansion coefficient (~ $2{,}6 \cdot 10^{-6}\ K^{-1}$)
  - Hydrophilic
  - Usually available as water suspension
  - High surface area
  - Material with practically unlimited fields of application

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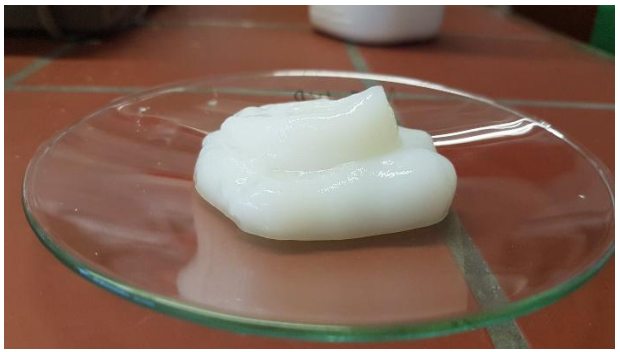
Production of nanofibirllated cellulose from wood

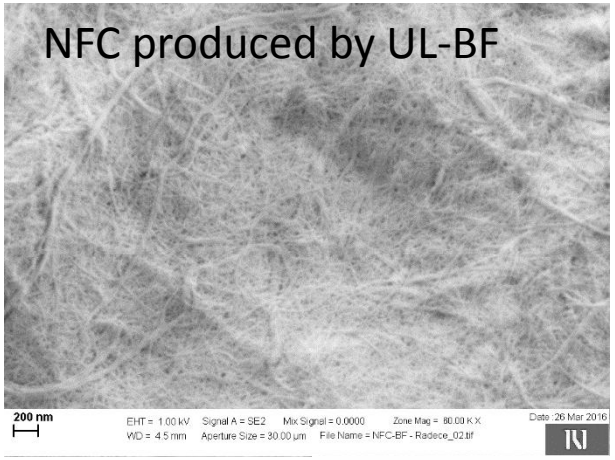
Extractives free wood/cellulose fibers

Mechanic treatment

- Homogenization
- Milling
- Ultrasound
- Chemical pretreatmet

Nanofibrillated cellulose - NFC
Diameter: 10 – 60 nm
Lenght: > 1 µm





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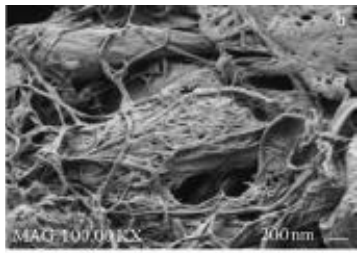
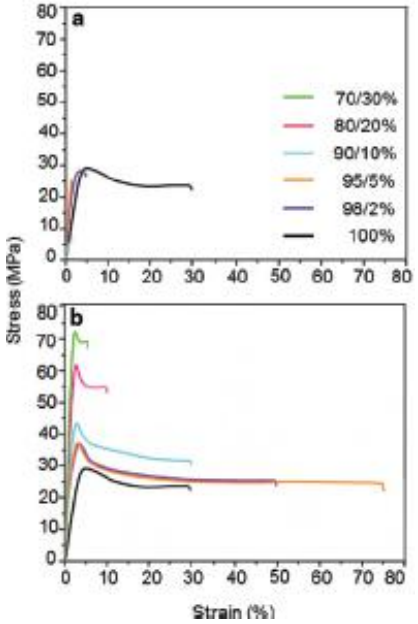
- UL-BF can deliver nanofibrillated cellulose
  - In different morphological properties
  - As water suspension or in dry form
  - As produced or in chemically modified form (Acetylation, TEMPO)
  - We can provid characterization (microscopy, thermal analysis, spectroscopy, XRPD, rheology)
  - Application of NFC (synthetic and bio-composites, paper, hydrogels, aerogels, various films, ...)





Conclusions

- Woody biomas of lower quality has great potential for production of non-timber products
- Two perspective directions are
  - High value/low volume extractives
  - Production and use of nanocellulose

- UL-BF has expertise in this fields and is opened for scientific or industrial co-operation!

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Education in the field of forest-wood chain in Slovenia

- University of Ljubljana is the oldest and largest higher education and scientific research institution in Slovenia.
- University of Ljubljana was founded in 1919.
- It has more than 40.000 undergraduate and postgraduate students and employs approximately 5.600 higher education teachers, researchers, and other staff
- 23 faculties and three art academies.
- The University of Ljubljana has close ties with Slovenian companies and foreign enterprises.
- Ranked among top 3 % in the world

- By 2020, the University of Ljubljana will be recognized as an internationally open and excellent research university.
- Projects:
  - o 428 European projects
  - o 174 research programmes
  - o 42 applied projects
  - o 168 basic projects
  - o 84 CRP
  - o 650 projects with the industry/users of knowledge

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University of Ljubjana
Biotechnical faculty (ULBF)

- The fundamental mission of the Biotechnical Faculty is to provide:
  - Education at university level,
  - advanced professional, and
  - postgraduate education,
  - to carry out scientific research and
  - technical and consulting work concerning the sciences:
- of living nature
- agriculture, forestry and fisheries
- and the related production technologies (wood technology, food technology, biotechnology).

- Seven departments
  - Agronomy
  - Biology
  - Forestry management and renewable forest resources
  - Landscape architecture
  - Wood science and technology
  - Zootechnique
  - Food technology

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Study programs at ULBF

- **Professional study programs**
  - AGRICULTURE - AGRONOMY AND HORTICULTURE
  - AGRICULTURE - ANIMAL HUSBANDRY
  - **FORESTRY**
  - **TECHNOLOGIES OF WOOD AND FIBRE COMPOSITES**
  - **WOOD ENGINEERING**

- **Academic study programs (BSc)**
  - BIOLOGY
  - BIOTECHNOLOGY
  - AGRICULTURE - ANIMAL PRODUCTION
  - LANDSCAPE ARCHITECTURE
  - MICROBIOLOGY
  - FOOD SCIENCE AND NUTRITION
  - **FORESTRY AND RENEWABLE FOREST RESOURCES**
  - **WOOD SCIENCE AND TECHNOLOGY**

- **Master study programs (MSc)**
  - AGRONOMY
  - BIOLOGY EDUCATION
  - BIOTEHNOLOGY
  - ECOLOGY AND BIODIVERSITY
  - ECONOMICS OF NATURAL RESOURCES
  - **FORESTRY AND FOREST ECOSYSTEM MANAGEMENT**
  - HORTICULTURE
  - INTERNATIONAL MASTER OF FRUIT SCIENCE
  - LANDSCAPE ARCHITECTURE
  - **WOOD SCIENCE**
  - MICROBIOLOGY
  - MOLECULAR BIOLOGY
  - MOLECULAR AND FUNCTIONAL BIOLOGY
  - NUTRITION
  - CONSERVATION OF NATURE AND NATURAL HERITAGE
  - ANIMAL SCIENCE
  - FOOD SCIENCE

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BIOSCIENCES - INTERDISCIPLINARY DOCTORAL STUDY PROGRAMME (http://www.bioznanosti.si/en)

Scientific fields

- Agrifood Microbiology
- Animal science
- Bioengineering in Health Science
- Bioinformatics
- Biology
- Biotechnology
- Cell sciences
- Economics of natural resources
- Food science
- Horticulture
- Landscape architecture
- **Managing forest ecosystems**
- Nanosciences
- Nutrition
- Protection of natural heritage
- Technical systems in Biotechniques
- **Wood and biocomposites**




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Thank You
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CELCYCLE Discarded potentials of biomass

TEC Slovenian Tool and Die Development Centre

Naložba v vašo prihodnost
OPERACIJO DELNO FINANCIRA EVROPSKA UNIJA
Evropski sklad za regionalni razvoj

ERA-NET Bioenergy

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