

# Exploring nanocellulose for lightweight structures in hiking and sports

*Tiina Härkäsalmi 9.1.2018 DCfFIII*

# Design approach of nano/micro fibrillated cellulose CNF



Material: Mechanically grinded  
cellulose nanofibrils CNF

~ 98 % water content

Origin: Pine or birch pulp

Formability???

Mouldability???

Technical qualities???

Processing methods???

Shrinkage 90%???

Drying time > energy consumption???

# Explorative methods



# Tube experiments



- E.g. birch tube: diameter 16,5 mm, hickness 0,61; length 95 mm, weight 3,99 g, density  $\sim 810 \text{ g/m}^2$ , strength/stress  $\sim 80 \text{ MPa}$



Hexagonal tube with 2,25 kg weight: CNF, Masuko3, pine (VTT),  
Dimensions: weight 9,2 g, length 150 mm, thickness of CNF ~ 0,53 mm

Tube with 4,75 kg weights: Material CNF, Masuko3, pine (VTT)  
Dimensions: weight 3,2 g; length 130 mm, diameter ~9,2 mm, thickness of CNF ~0,73 mm



# Camping stool I

## Fabric

- Knitted composite  
loncell-F –filaments  
(Michael Hummel &  
Sherif Elsayed Aalto/CHEM)  
PLA-filaments

## Tubes

- Inner layer  
plywood  
(Veneer/Mahogany + PLA)
- Cellulose nanofibrils
- Reinforcement  
loncel-F filament knit



Photos: Eeva Suorlahti

# Camping stool II



## Materials:

### Fabric

- Linen

### Tubes

- Cellulose nanofibrils
- Reinforcement
- Ioncel-F filament knit

## Properties:

- Light-weight
- Strong
- Only renewable materials
- Non-toxic
- Totally biodegradable



# CNF-bike



Team:

Kim-Niklas Antin, Design and manufacturing Aalto/ENG

Tiina Härkäsalmi, Nanocellulose tubes Aalto/ARTS

Tuomas Pärnänen, Composites fabrication and finishing Aalto/ENG

Photo: Eeva Suorlahti





Photos: Eeva Suorlahti

# Kayaking paddle

## Team:

Tiina Härkäsalmi &  
Ville Arkonkoski Aalto/ARTS

## Materials:

Mechanically grinded cellulose  
nanofibrils CNF

Knitted reinforcement;

Ioncell-F filaments: Michael Hummel &  
Sherif Elsayed Aalto/CHEM

Easy to customise: colour, size, shape of  
the paddle blade and the paddle shank

Preliminary economic calculations showed  
business potential even for small scale  
production



# Results

- Technical properties: light and strong, tailorable material properties
- Manufacturing processes: a layer by layer method or a mono-layer, high shrinkage in drying process > special requirements for form and mould design
- Sensorial properties
  - Visual: opaque, non-reflective, light absorbing, high variety of colourfulness, high intensity of colours
  - Smell: odourless (dry/wet)
  - Touch: from smooth to rough depending on the mould surface or surface finishing, hard/semihard/, warm handle, wood-like touch
  - Sound: “clattering”
- Sustainability: renewable materials 100 %, easily recyclable/reusable, (bioeconomy, circular economy), biodegradable and compostable, mono-material, non-toxic, traceability (certified pulp)
- Health: no outgassing, non-allergenic, non-toxic, odourless
- Customers: environmentally conscious consumers, outdoorsy person, get empowered by nature

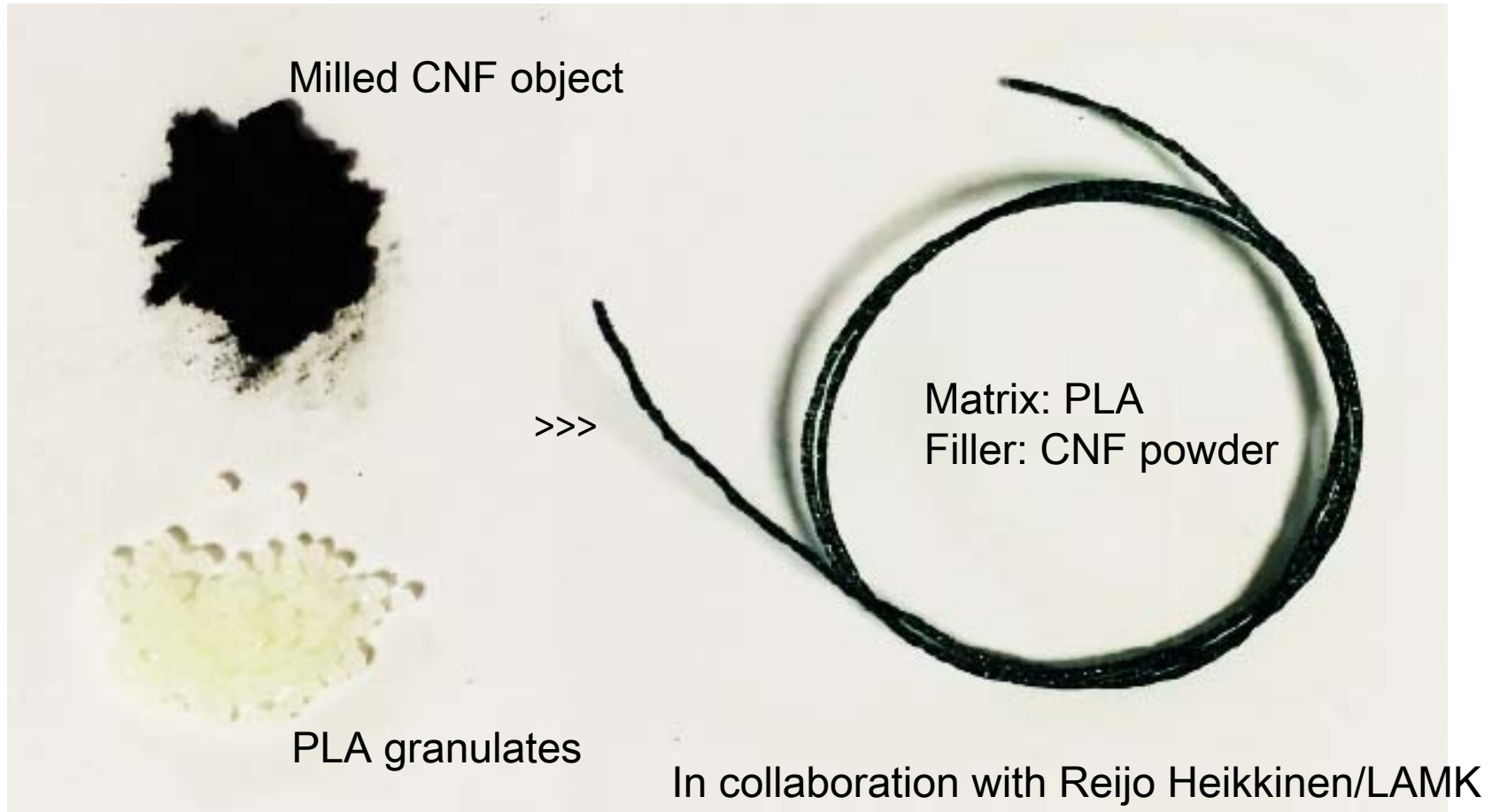
# The tube-processing methods can easily be applied in different forms....



Photos: Eeva Suorlahti



# Design for Circular Bioeconomy: Reuse of CNF in filament for 3D-printing







# Thank You!

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25 % Dyed CNF + 75 % native CNF