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Novel structural materials with multi-scale fibre components

Tekes LAMK

Novel structural materials with multi-scale fibre components (NoMa)

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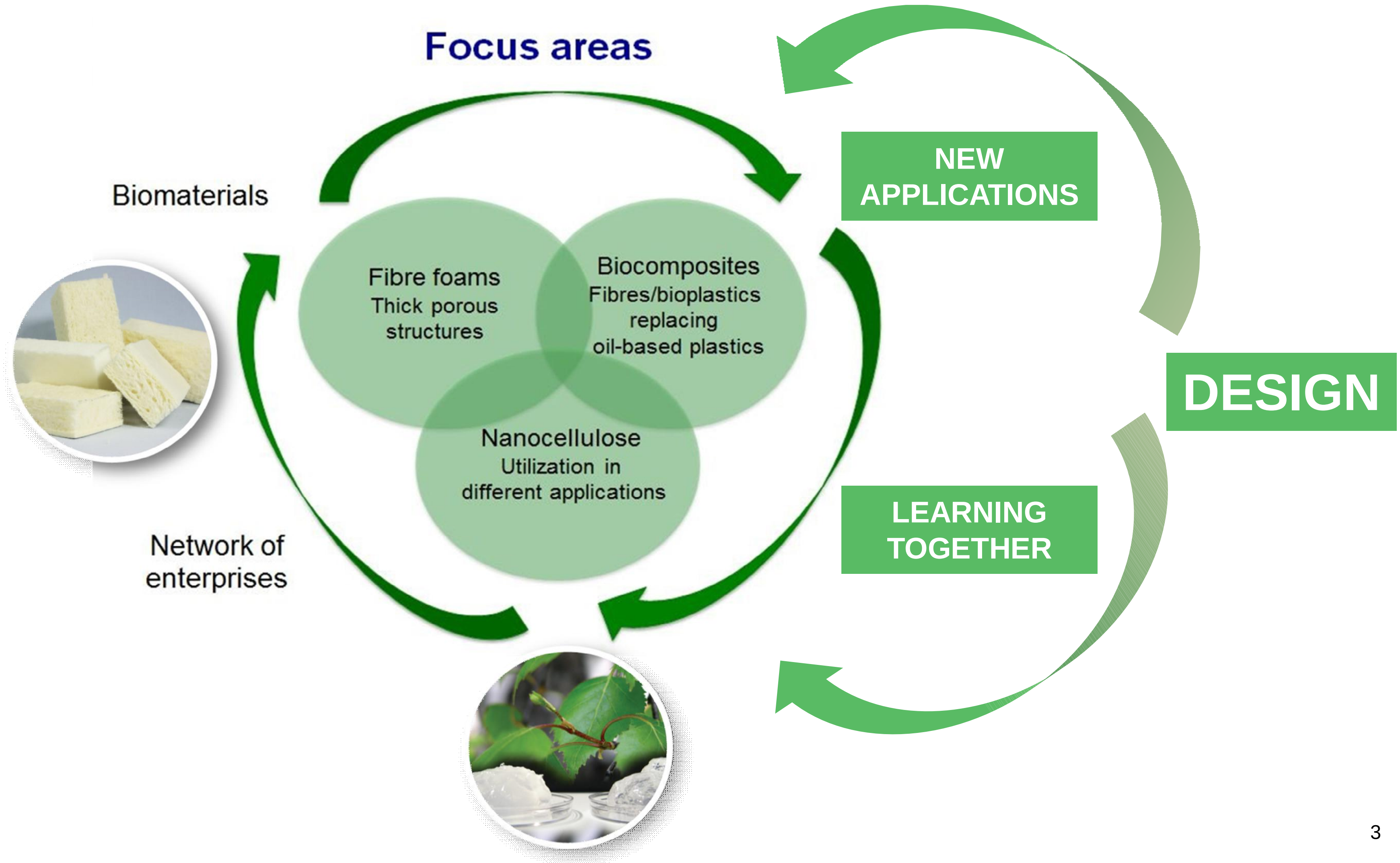
DesignMuseo 13.06.2017

NoMa consortium

SMALL ENTERPRISES
3D Formtech Oy
3DTech Oy
Ahosen Taimisto Oy
Brainwood Oy
Co. Panu Isokangas Oy
Earthpac Oy
Novarbo Oy
Epira Oy
Hikinoro Oy
Swanheart Design Oy
FL-Pipe Oy
LARGE ENTERPRISES
Metsä Board
Metsä Fibre

- **Budget of project ~1.3 M€**
- **Duration 01.6.2015 - 30.11.2017**
- **Research partners: VTT and LAMK**
- **Funding partners:**
  TEKES, VTT, companies and LAMK

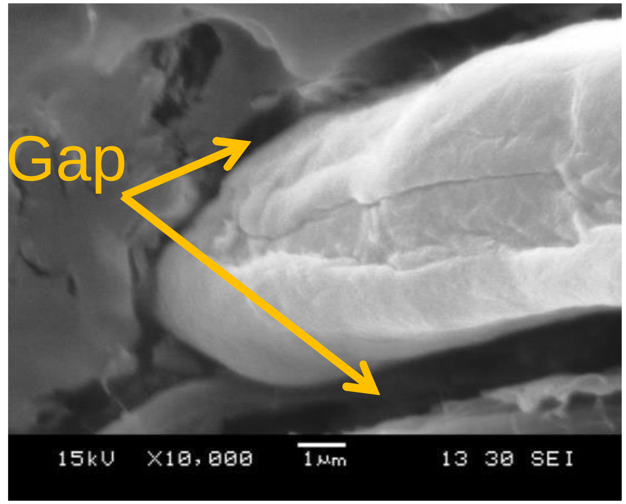
Novel fibre foams and biocomposites applications

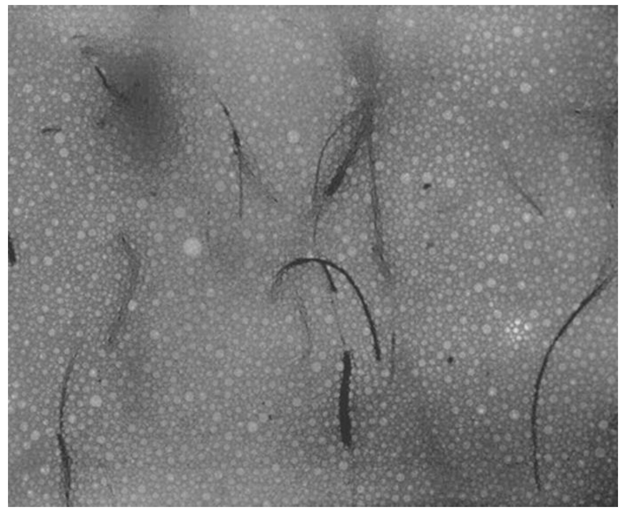


Goal of the study

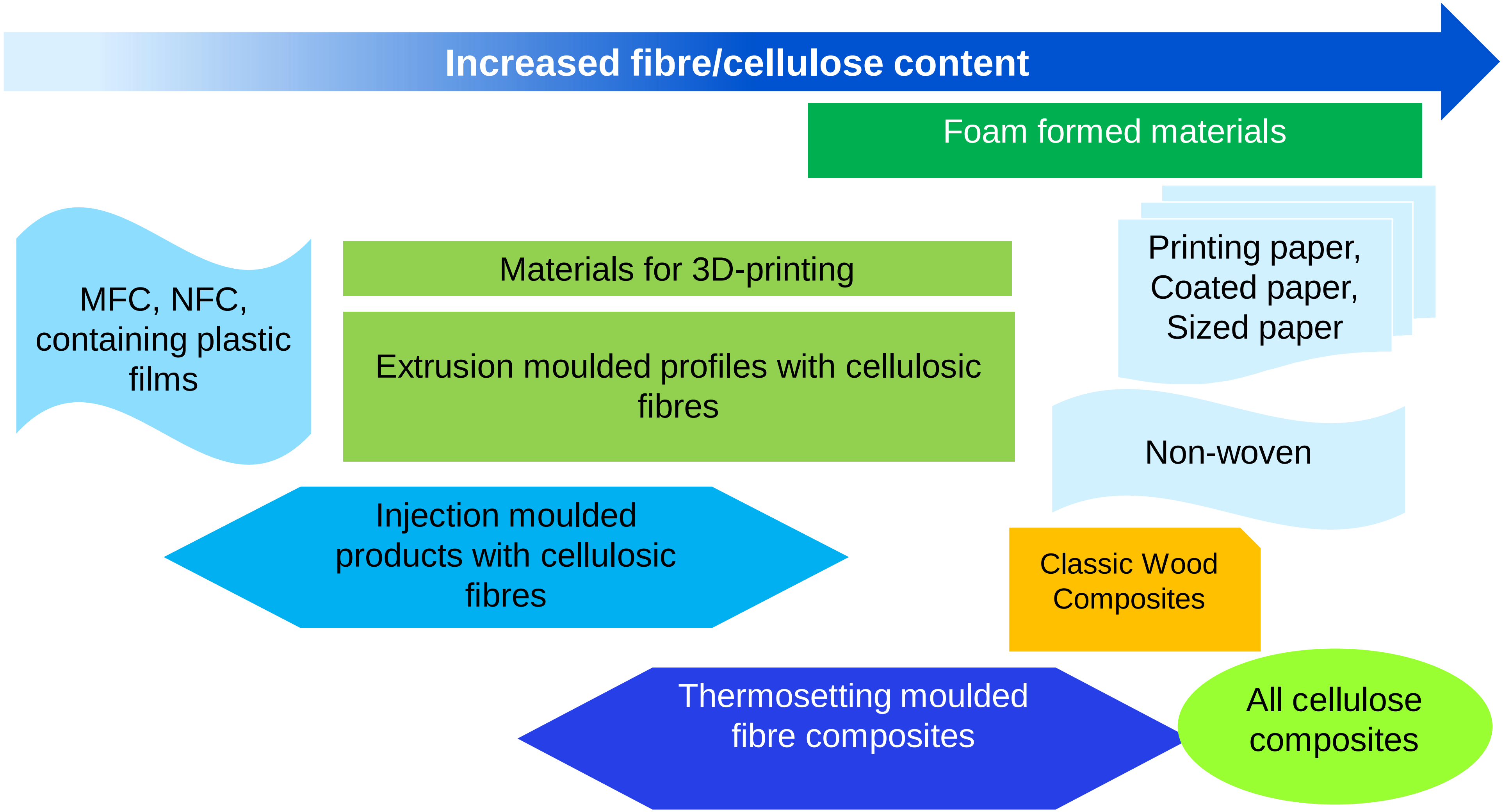
Multi-scale fibres (from centimeters to nanoscale, various aspect ratios) for stronger material structures

- **Optimal combination** of fines, long fibers, nanocelluloses, polymers and additives to obtain **good adhesion in biocomposites and bonding in fibre foam structures**
- Novel bio based products for SMEs through **innovative raw material combinations** (hemp fractions, hydrophobins, lignocellulosic fines, nanocelluloses, wood wool, side streams) and **technologies** combined **with design approach**





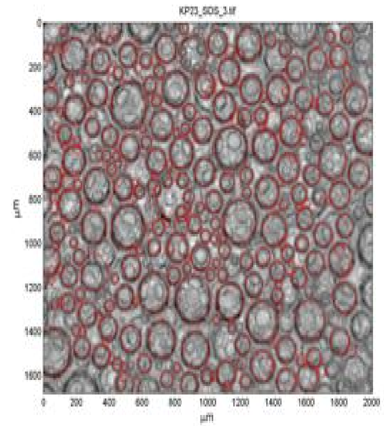
Fibre composites according to fibre content

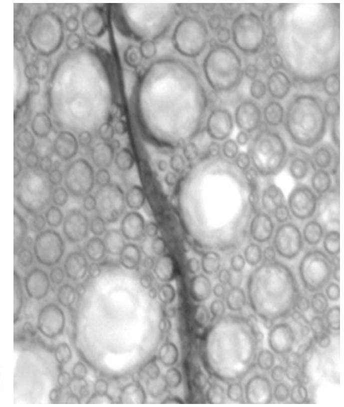


Fiber foams

- **Fiber suspension + air**
  - Typical air content 40 - 70%
  - Foam stability can be controlled
  - Typical bubble diameter ~100 µm

- **No fiber flocculation**
  - Small bubbles fill the free space





Foam forming of low density structures

- Foaming of water-fiber-surfactant mixture to reach air content 50 - 60%
- Foam is poured into a foam forming mould, size 42 x 42 cm^2
- Drainage of liquid using gravity or low vacuum level, no wet pressing
- Drying in oven 60 - 70°C, ~24 h, drying time depends on pulp type

Foaming vessel

Forming mould with fibre foam

In-plane dried structures of different thicknesses in

Application: Light weight inner packages

- Light and soft fibrous cushioning element that protects the product from impacts
- Product shape made in manufacturing phase
- Replacement of non-biodegradable EPS based inner packages (Europe: 1.6 million tons of EPS waste in 2010)

Foam formed inner package

Cellulose fibre material to replace plastic bubble wrap
Design: Kaisa Jäntti, LAMK
Materials and foam forming: VTT
Photos: Kaisa Jäntti, LAMK and Juha Hakulinen, VTT

Kiiskinen H., Torniainen E., Kinnunen K., Method of forming a fibrous product, WO 2015/036659 A1

Application: Designed decorative sound absorber panels

Kaarna wall panels designed by Hannakaisa Pekkala LAMK
Exhibition of "Designed Cellulose For Future II" in May 2016, Helsinki

- Foam forming and design-driven aspect lead to designed porous structures with special 3D form and sound absorption property
- Cellulose pulp used as raw material instead of highly processed and disposable materials

Multi-scale material experiments:
Hemp, refined bark and wood wool fractions with cellulose pulp

Multi-scale material experiments: Hemp fractions, fibres, bast and dust with polymers

3D printed biocomposite decorative hydrogels

Patent pending

Exhibition of ”Designed Cellulose For Future II” in May 2016, Helsinki Aalto Arts

3D printed bio-based hydrogels for decorative applications
Design Susanna Kettunen LAMK
3D printing and material development: VTT
Photo: Juha Hakulinen VTT

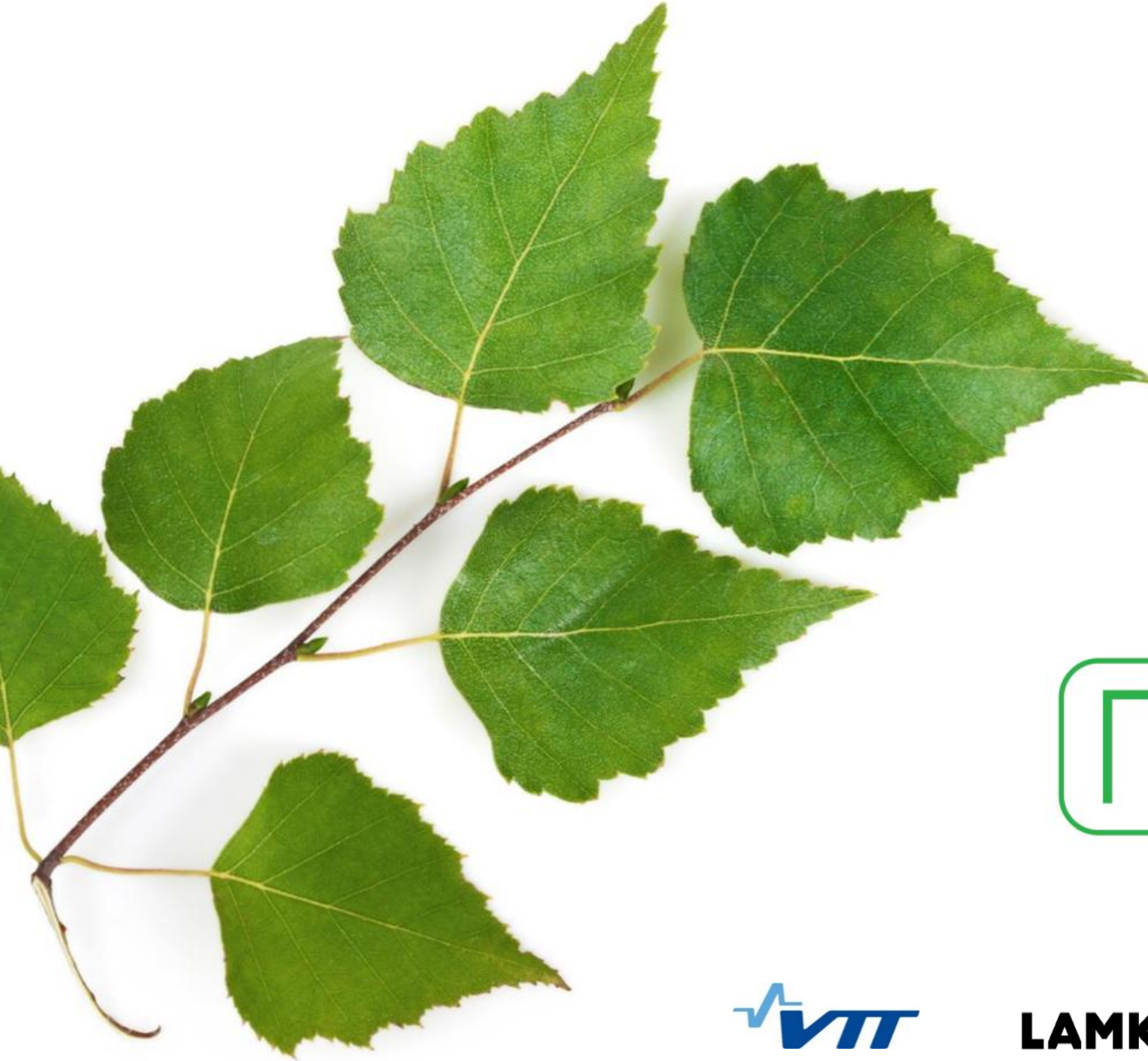
Pure 100% cellulose pulp sheets moldable materials

Moldable pure cellulose pulp sheets
Design: Tomi Laukkanen LAMK
Materials: Metsä Group
Photos: Juha Hakulinen VTT

3D printed wood sawdust and biopolymer stimulus toys for production animals

3D printed toys for animals
Design: Kristoffer Heikkinen LAMK
3D printing: 3DTech
Commercial materials
Photos by Juha Hakulinen VTT

Exhibition of ”Designed Cellulose For Future II” in May 2016, Helsinki



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VTT

LAMK Lahden ammattikorkeakoulu
Lahti University of Applied Sciences

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