Designing for Sustainable Bio-based Materials

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Design Yesul Woo CHEMARTS 2018 photo Eeva Suorlahti

Pirjo Kääriäinen
Professor of practice, Design driven fibre innovation
ARTS Design + CHEM Bio^2

My heart:
Nature
Creativity
Explorations

My background:
Textile industry
Design + Management
Entrepreneurship

My passion:
Materials research
Design + Science
Interdisciplinarity

Photo Eeva Suorlahti

CHEMARTS *is a strategic collaboration in education and research between the School of Arts, Architecture and Design and the School of Chemical Engineering.*

Photo Eeva Suorlahti

*The aim of **CHEMARTS** is to inspire designers and material researchers to explore bio-based materials for innovative applications and for more sustainable material future.*

Today's topics:

1) Bio-based materials

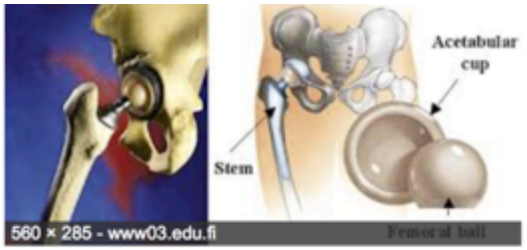
2) About new production technologies

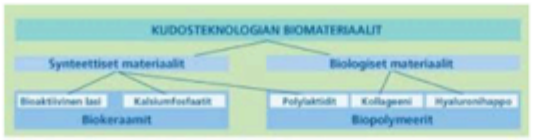
3) Designers in material research

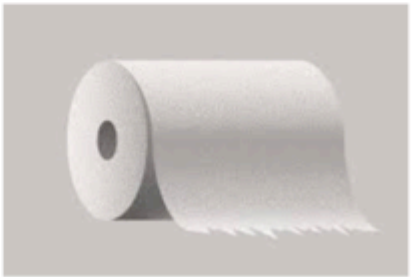
Wood dust + nanocellulose by Heidi Turunen, DWoC 2017

Kuva Eeva Suorlahti

Biomaterials? Bio-based materials?







1. Bio-based materials

www.CelluloseFromFinland.fi


75% of Finland is covered by forests
60% more wood than 100 years ago
Richness of the Finnish nature
How to combine ecological values, nature experiences and economical aspects in a sustainable way?

Finland's top export products 2017

1. Paper and paperboard
6,9 bill. EUR

5. Wood pulp
2,0 bill. EUR

6. Softwood sawnwood
1,9 bill. EUR

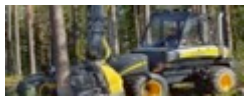
2. Diesel fuel
4,5 bill. EUR

3. Stainless steel
2,7 bill. EUR

4. Motor vehicles for personal transport
2,4 bill. EUR

7 Ships and boats
1,5 bill. EUR

8. Electric generators and motors
1,4 bill. EUR



9. Earth movers and excavators and other similar machinery
1,2 bill. EUR

10. Special machinery
1,1 bill. EUR

A!

What about design products? Sustainable fashion? Cosmetics?


Concepts for
material design
Transforming
Reinventing
Recycling
Growing
Designing
Photo Eeva Suorlahti

Pathways towards sustainable materials

Concept	Materials	Enablers	Objectives
Transforming *natural raw materials or industry/agriculture side streams/waste into new materials*	Wood, plants, algae - anything containing cellulose, or protein-based materials such as feathers etc.	New or renewed, sustainable and resource-efficient production processes	Only renewable raw materials Sustainable processes with non toxic chemicals
Reinventing *traditional materials and production technologies*	Willow, hemp, nettle, wood etc. Natural dyes and non toxic chemicals based on natural ingredients	Sustainable cultivation systems, and renewed production processes	Learning from the nature Learning from the past Combining tradition with new technologies
Recycling *all materials*	For example textiles like cotton, polyester, lyocell; plastics, electronics –everything!	Efficient collecting and mechanical and chemical etc. processes	Less need for virgin materials Minimizing waste Closing the loop
Growing *new materials*	Microbe or fungi with proper nutrition	Biofabrication processes Synthetic biology Bioart, biodesign	No waste materials No extra production phases
Designing *materials with biotechnologies*	Living cells from various sources, treated with genetic engineering	Synthetic biology New production processes	Totally new materials with designed material properties Production processes inside factories

Modified from: Niinimäki, Salolainen, Kääriäinen (2018) Opening up New Textile Futures through Collaborative Rethinking and Remaking

Example: Transforming

Photo Eeva Suorlahti

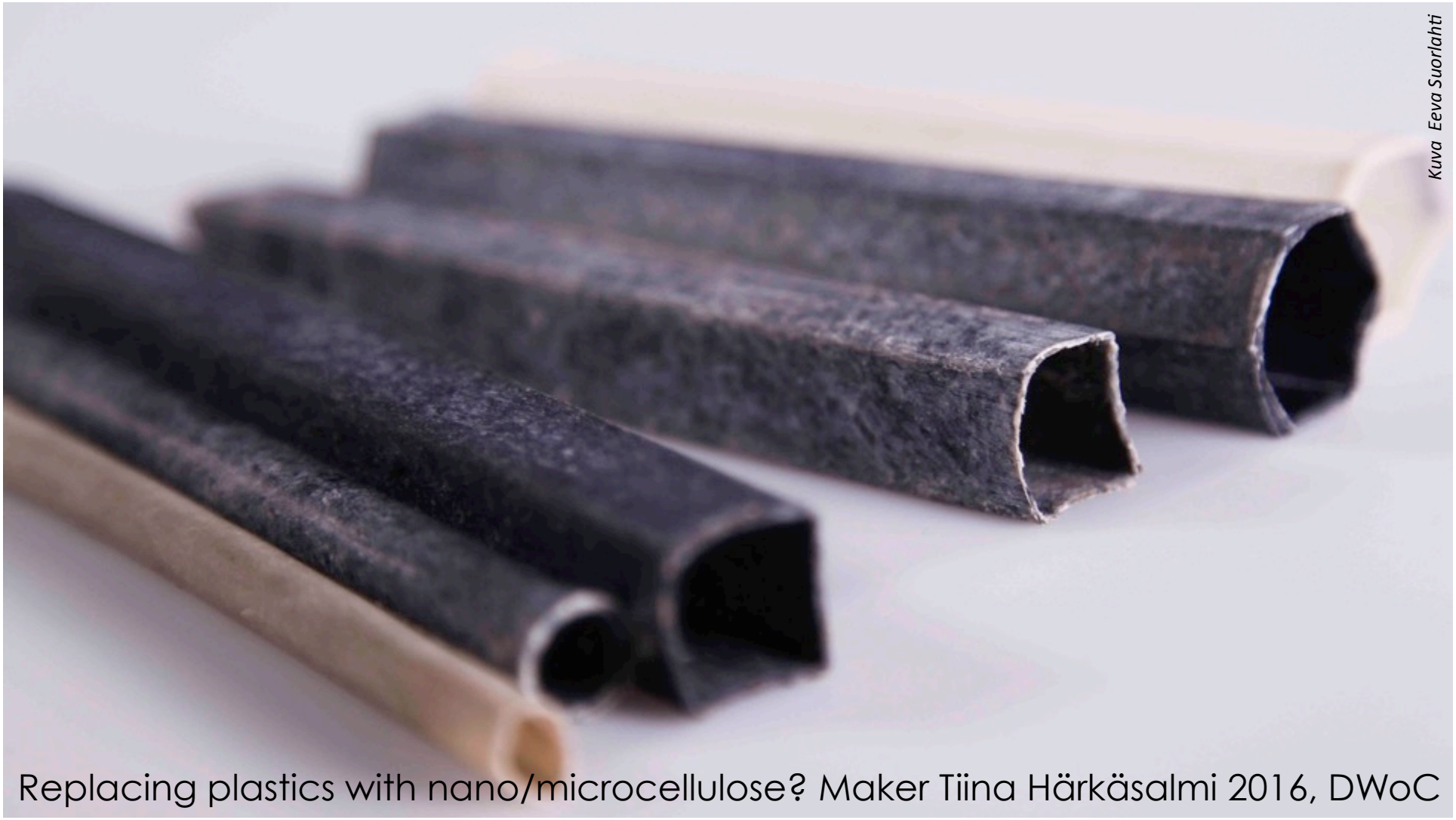
Designing Cellulose for the Future

Design Driven Value Chains in the World of Cellulose (DWoC) is an interdisciplinary materials research project 2013-2018, funded by Tekes (Now Business Finland) www.CelluloseFromFinland.fi

Example: Transforming wood to nanocellulose

Photo Eeva Suorlahti

Tempo-oxidized nanocellulose by Nina Riutta, CHEMARTS 2017



Replacing plastics with nano/microcellulose? Maker Tiina Härkäsalmi 2016, DWoC

DESIGN DRIVEN
VALUE CHAINS
IN THE **WORLD**
OF CELLULOSE
DWoC

Fireretardant nanocellulose coating for wood by Heidi Turunen & VTT DWoC 2017

Photo Eeva Suorlahti

Light-weight nanocellulose stool by Tiina Härkäsalmi, DWoC 2017

THE SULAPAC STORY

The inspiration for Sulapac's innovation lies in the Finnish forest. Founders Suvi Haimi and Laura Kyllönen wanted to develop a beautiful and ecological packaging material that would help to reduce the plastic waste.

Example: Transforming natural materials into textiles

Design Anna-Mari Leppisaari, photo Eeva Suorlahti

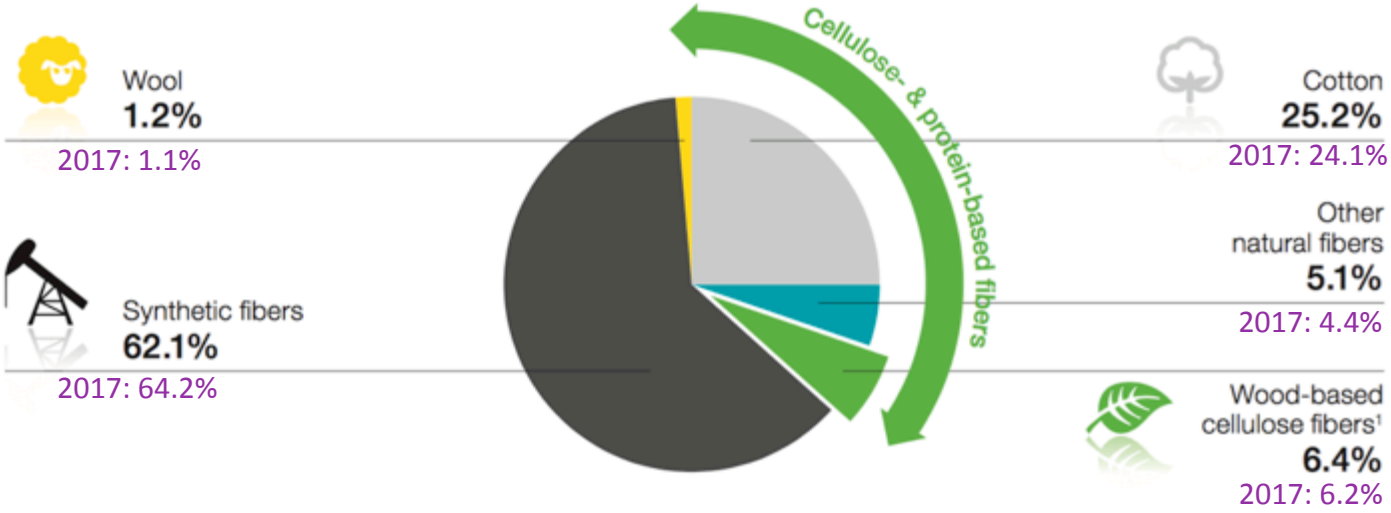
Ioncell, new sustainable technology to produce high quality textile fibres from wood or cellulosic waste by Prof. Sixta's team (with the University of Helsinki)


Design Matilda Tuure, photo Valeria Azovskaya

Non toxic, waterproof textile finishing by Prof. Österberg's research team

Global fiber market

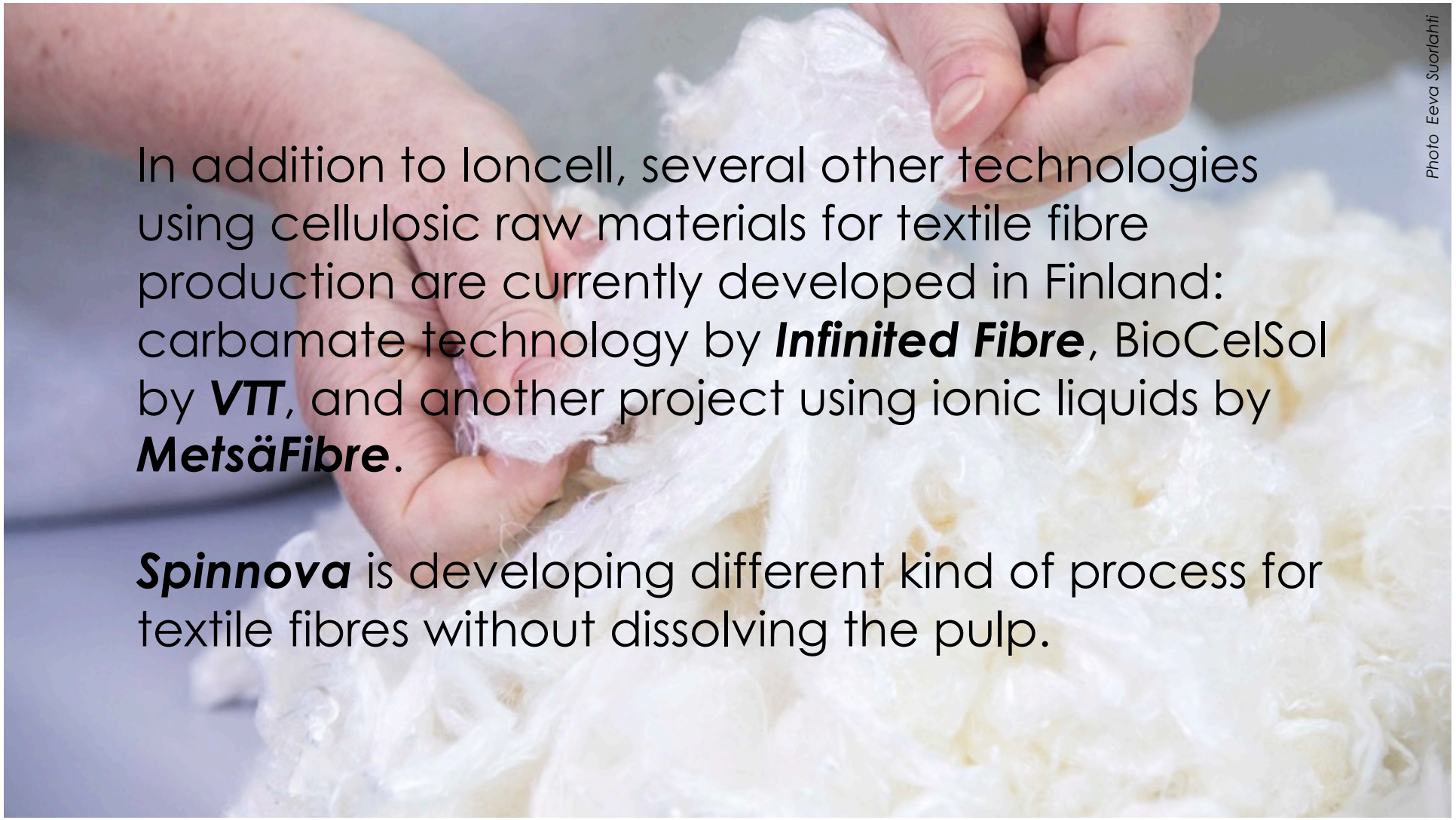
Global fiber consumption 2015 94 million tons 2017: 105 million tons



¹) Wood-based and cotton linter-based cellulose fibers

Source: ICAC, CIFRS, TFY, FEB, Lenzing estimates

Source: Lenzing annual reports 2015, 2017



In addition to Ioncell, several other technologies using cellulosic raw materials for textile fibre production are currently developed in Finland: carbamate technology by ***Infinited Fibre***, BioCelSol by ***VTT***, and another project using ionic liquids by ***MetsäFibre***.

Spinnova is developing different kind of process for textile fibres without dissolving the pulp.

Photo Eeva Suorlahti

Example: Reinventing natural materials

Willow bark CHEMARTS 2017

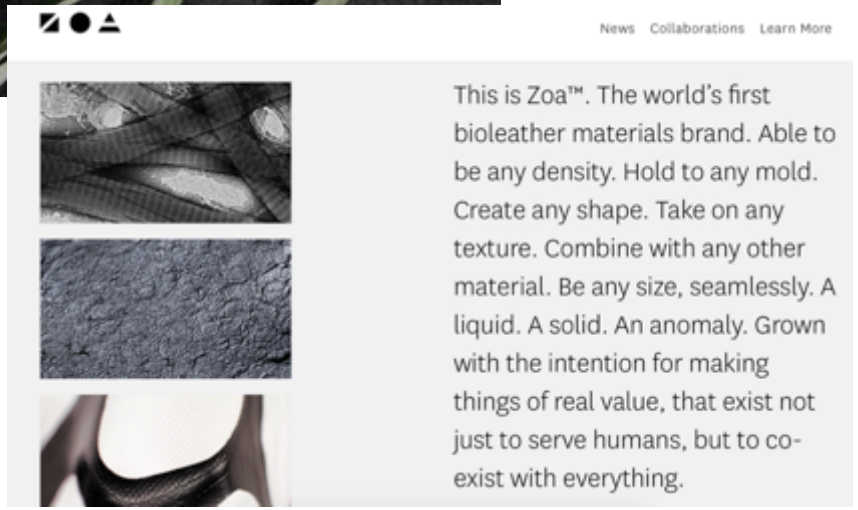
Example: Reinventing natural materials

Photo Eeva Suorlahti

Willow bark dish by Eveliina Juuri & Sanna-Liisa Järvelä CHEMARTS 2017

Signal of change / Manure couture - making cow manure-based fabric

YOUR NEXT HANDBAG MIGHT BE MADE OUT OF WINE



Recycling:
Raw materials for the future

English: Classified home trash for aid the recycle process. Numbers for description have been added. A original copy without numbers can be submitted by me on request. 1) glass bottles, 2) thin plastic, 3) thick plastic, 4) cardboard, 5) no classified, 6) cans, 7) paper, 8) polystyrene, 9) glass fragments, 10) batteries, 11) metals, 12) organics, 13) tetrapak, 14) fabric, 15) wc.

A! Example: Recycling for textile materials

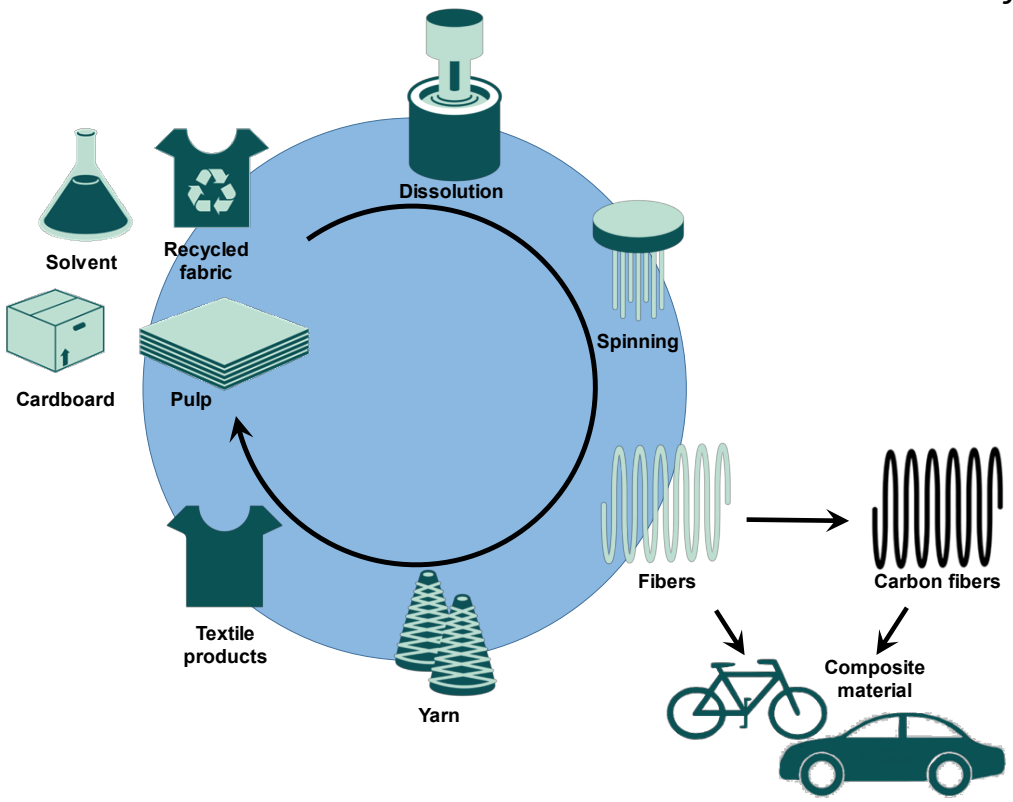
Design Ioncell team 2018, photo Mikko Raskinen

Design Marjaana Tanttu, DWoC project 2017, photo Eeva Suorlahti

Recycling and upcycling waste materials (textile waste, paper, cardboard) by Ioncell process by Prof. Sixta's research team

IONCELL

ioncell.fi



Circular process enabling circular economy

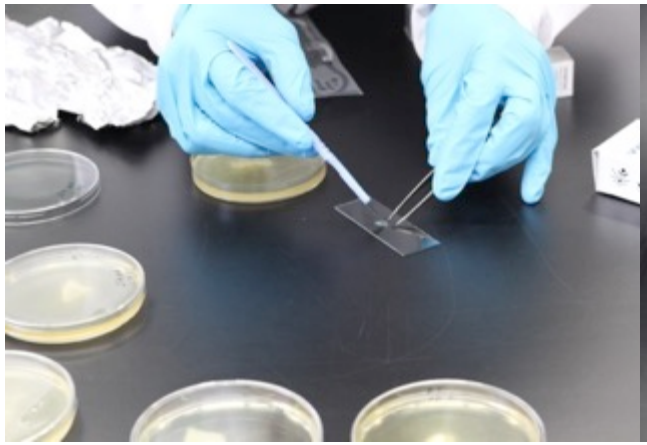
ecouterre NEWS INNOVATION APPAREL FEATURED MORE

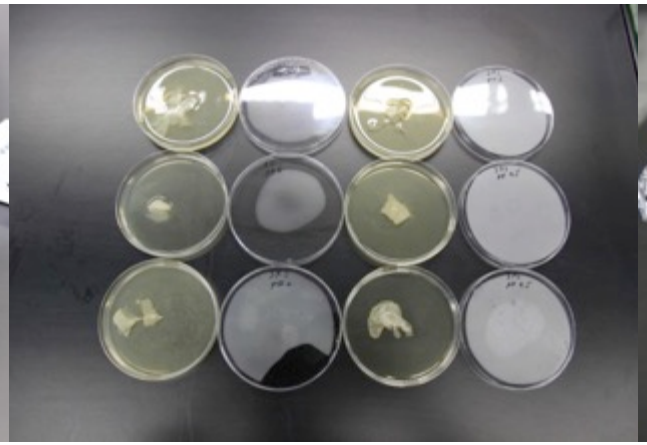
Finch Designs Recycles Plastic Bottles Into Rain Capes, Swimsuits

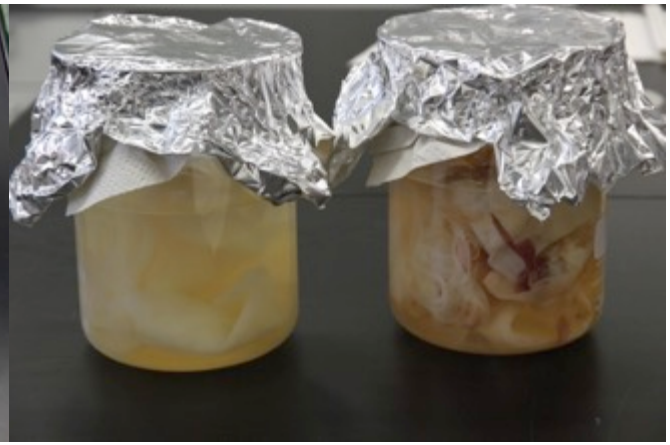
ECO-FASHION BRANDS

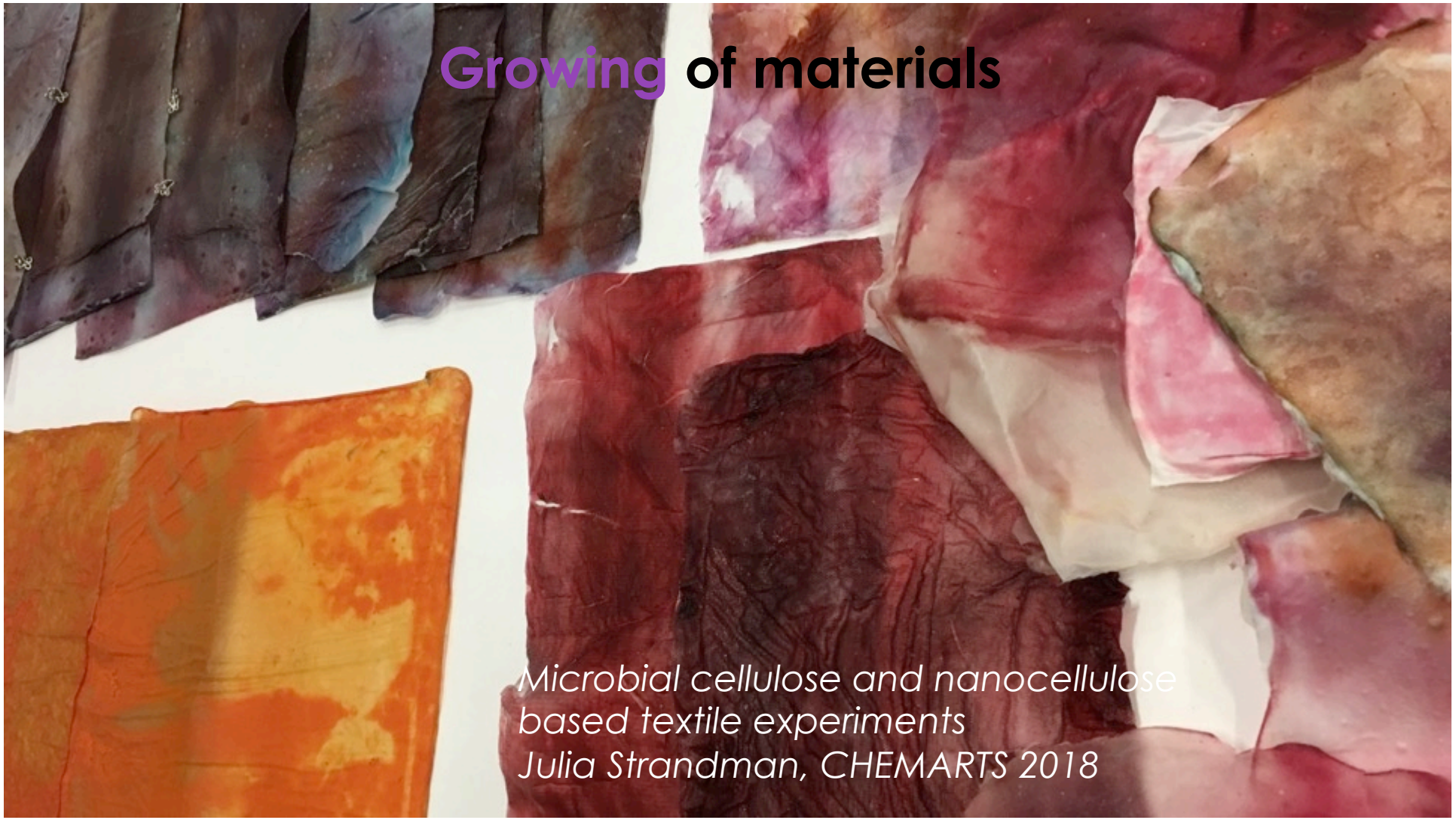
Designed by London-based Alexander Taylor, the shoes are made using Adidas' existing footwear manufacturing processes but the usual synthetic fibres are replaced with yarns made from the recycled Parley Ocean Plastic.

Growing of materials





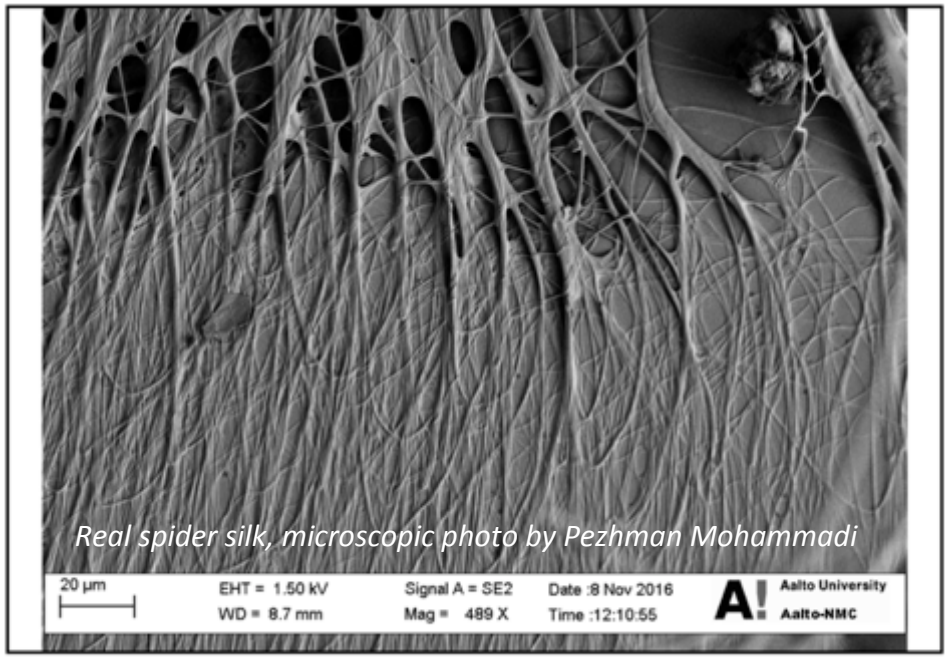



Growing of materials
Microbial cellulose and nanocellulose based textile experiments
Julia Strandman, CHEMARTS 2018

Growing of materials

http://www.fungal-futures.com/
MycoTEX-Mycelium-Textile
By Aniela Hoitnik

Designing materials with biotechnologies



Real spider silk, microscopic photo by Pezhman Mohammadi

New Silk - Bio-based production of silk-like materials, research project inspired by spider silk by Prof. Linder's research team

Photo Eeva Suorlahti

2) About new production technologies

Foam forming VTT 2017

DESIGN DRIVEN
VALUE CHAINS
IN THE WORLD
OF CELLULOSE
DWoC

Foam forming saves water

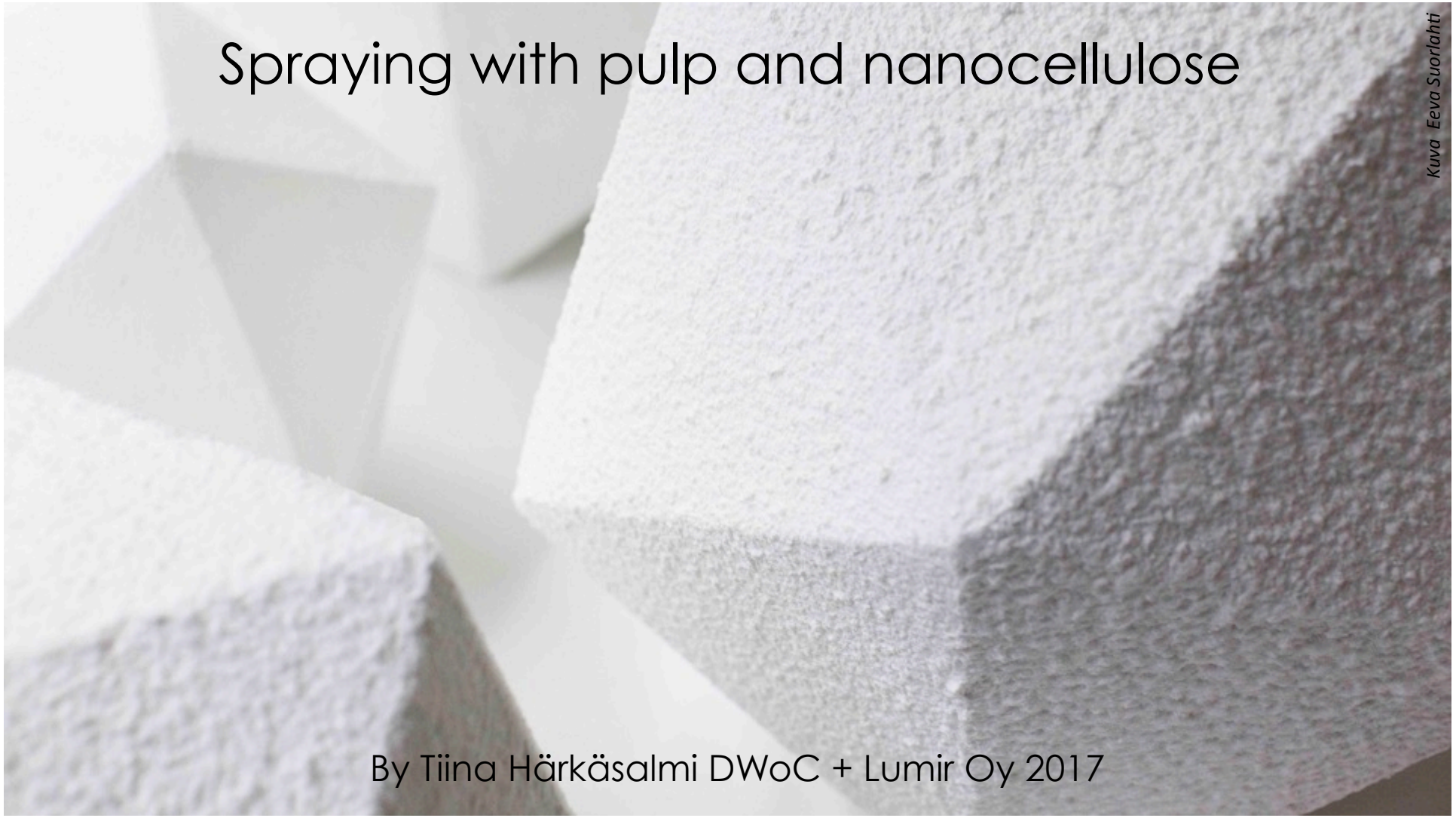
Photo Eeva Suorlahti

Foam formed, acoustic panels from wood pulp by Tiina Härkäsalmi + VTT DWoC 2017

Photo Eeva Suorlahti

Prototype for biodegradable shoes by Saara Kinnunen HAMK + VTT DWoC 2017

Spraying with pulp and nanocellulose



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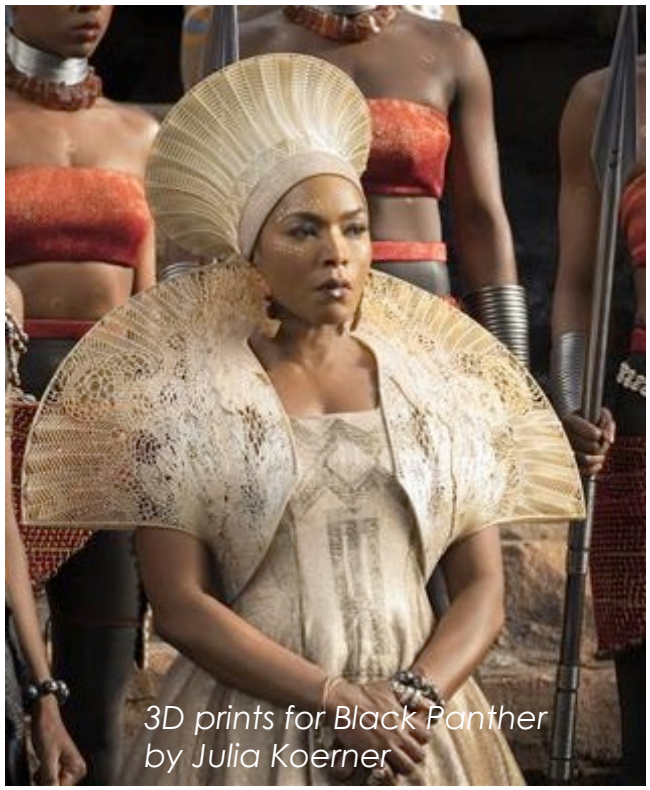
By Tiina Härkäsalmi DWoC + Lumir Oy 2017



3D prints for Black Panther
by Julia Koerner

Continuum Fashion 2015

digital grotesque 2017
by hansmeyer / dillenburger

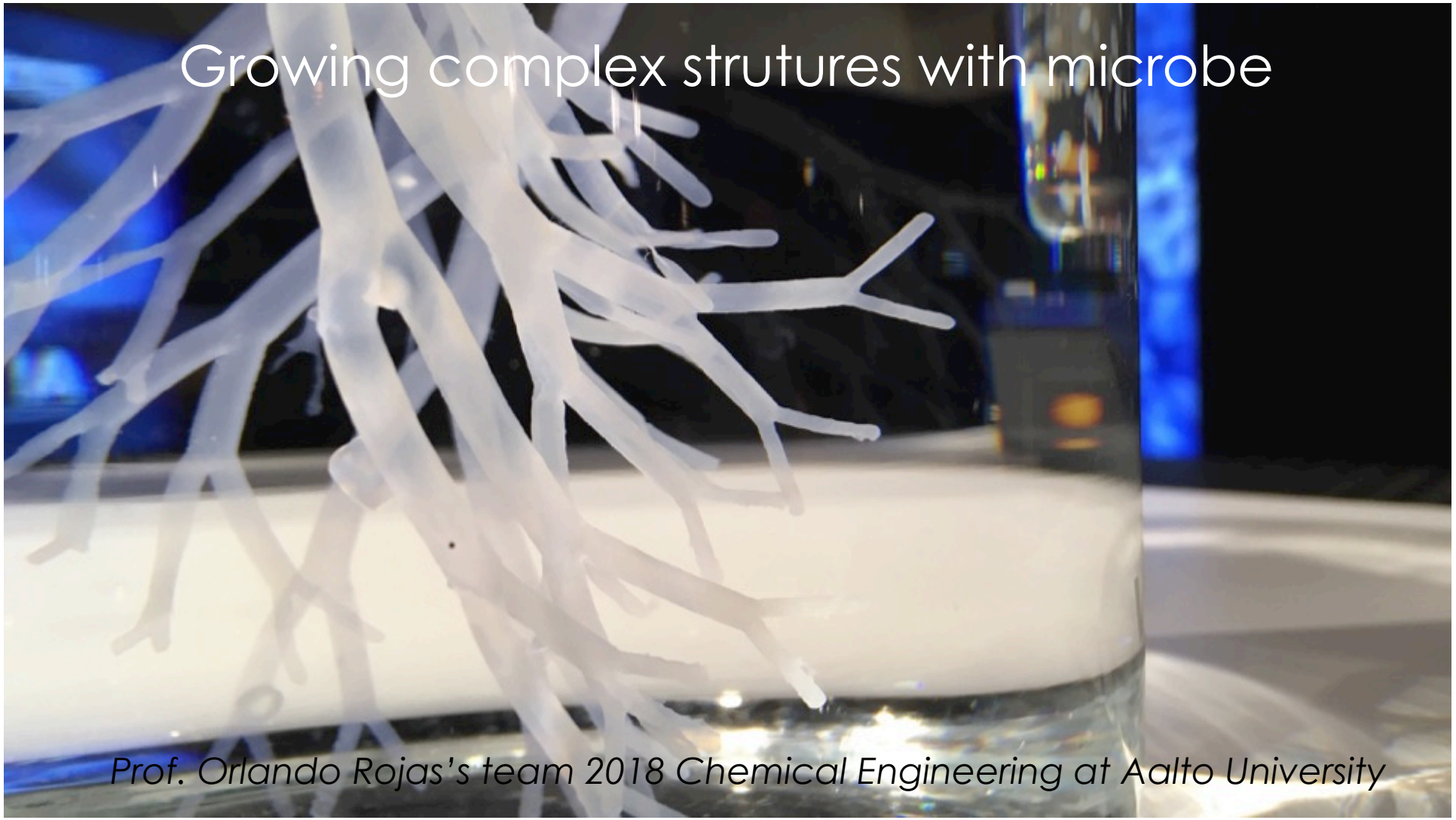
3D printing: New technology, new visual language

Fashion designer Suzanne Lee
Biocouture 2014

Carole Collet

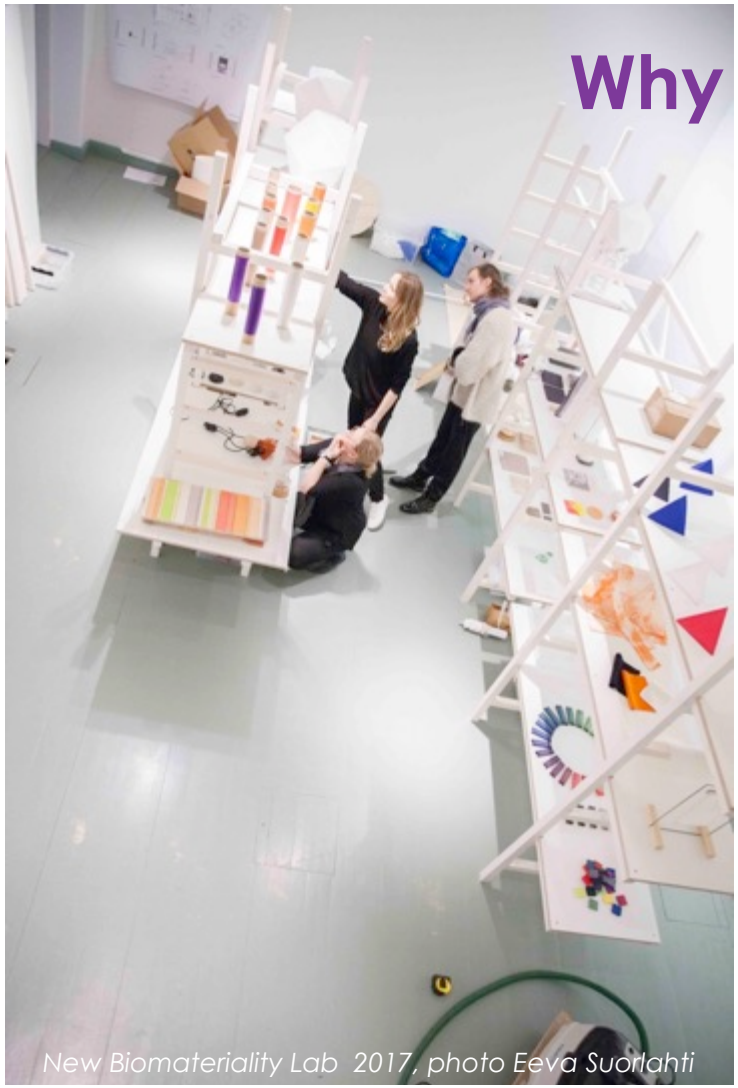
Grow your products?

Fungi jewelry by Manuel Arias Barrantes & VTT, 2017


Growing complex strutures with microbe
Prof. Orlando Rojas's team 2018 Chemical Engineering at Aalto University

CellPod by Niko Räty 2017 in collaboration with VTT for food production

3) Designers in material research

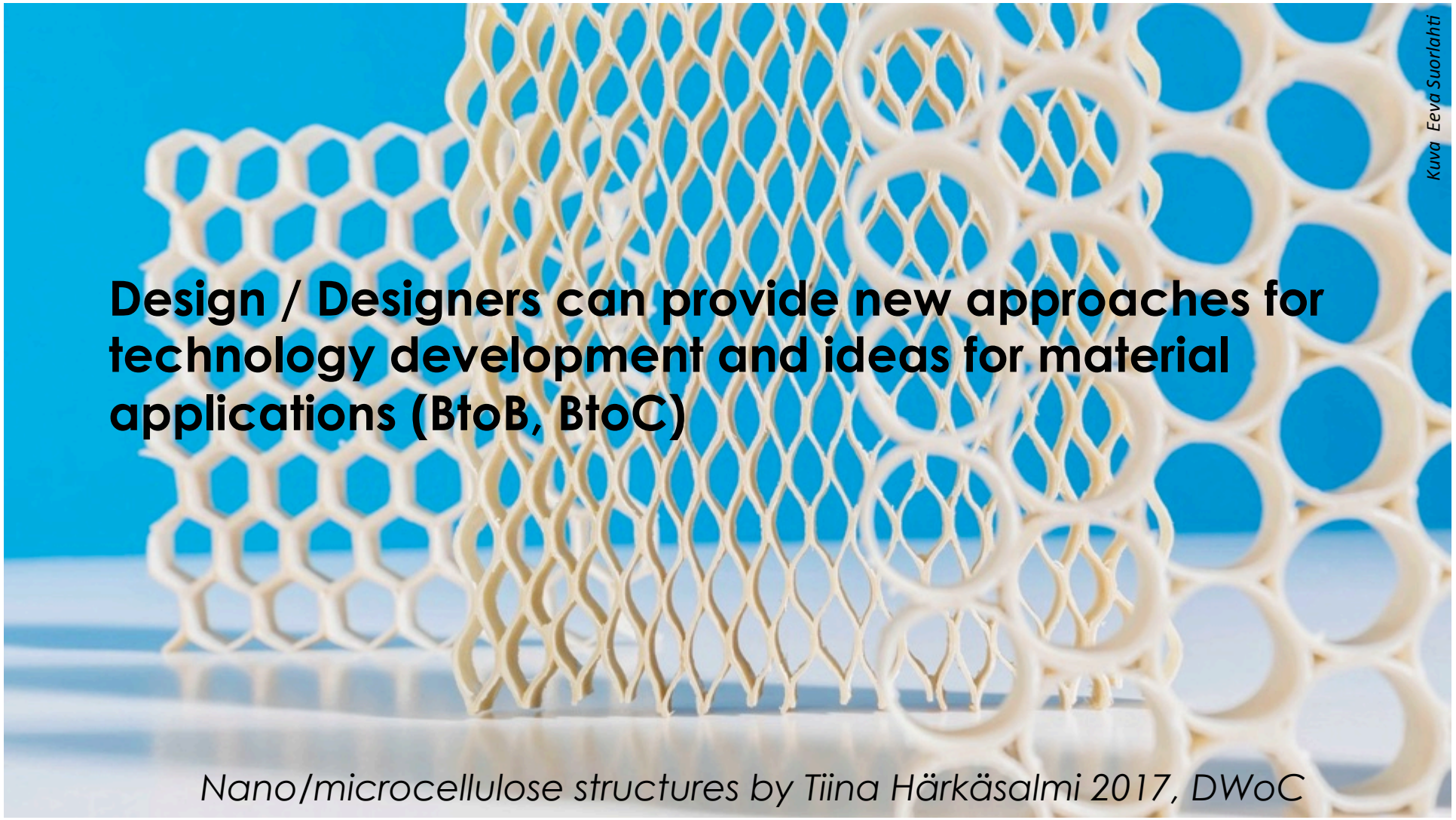


New Biomateriality Lab 2017, photo Eeva Suorlahti

Why Design with Material Research?

- Design process includes an integrative and holistic approach
- Design process provides methods for co-creation, quick prototyping and testing
- Designers are often future-oriented
- Designers can communicate even non-existing things and speculate with future through visualisation and prototyping

>supports very slow material development processes by making them understandable



Design / Designers can provide new approaches for technology development and ideas for material applications (BtoB, BtoC)

Nano/microcellulose structures by Tiina Härkäsalmi 2017, DWoC

How to control material (cellulose) shrinkage?

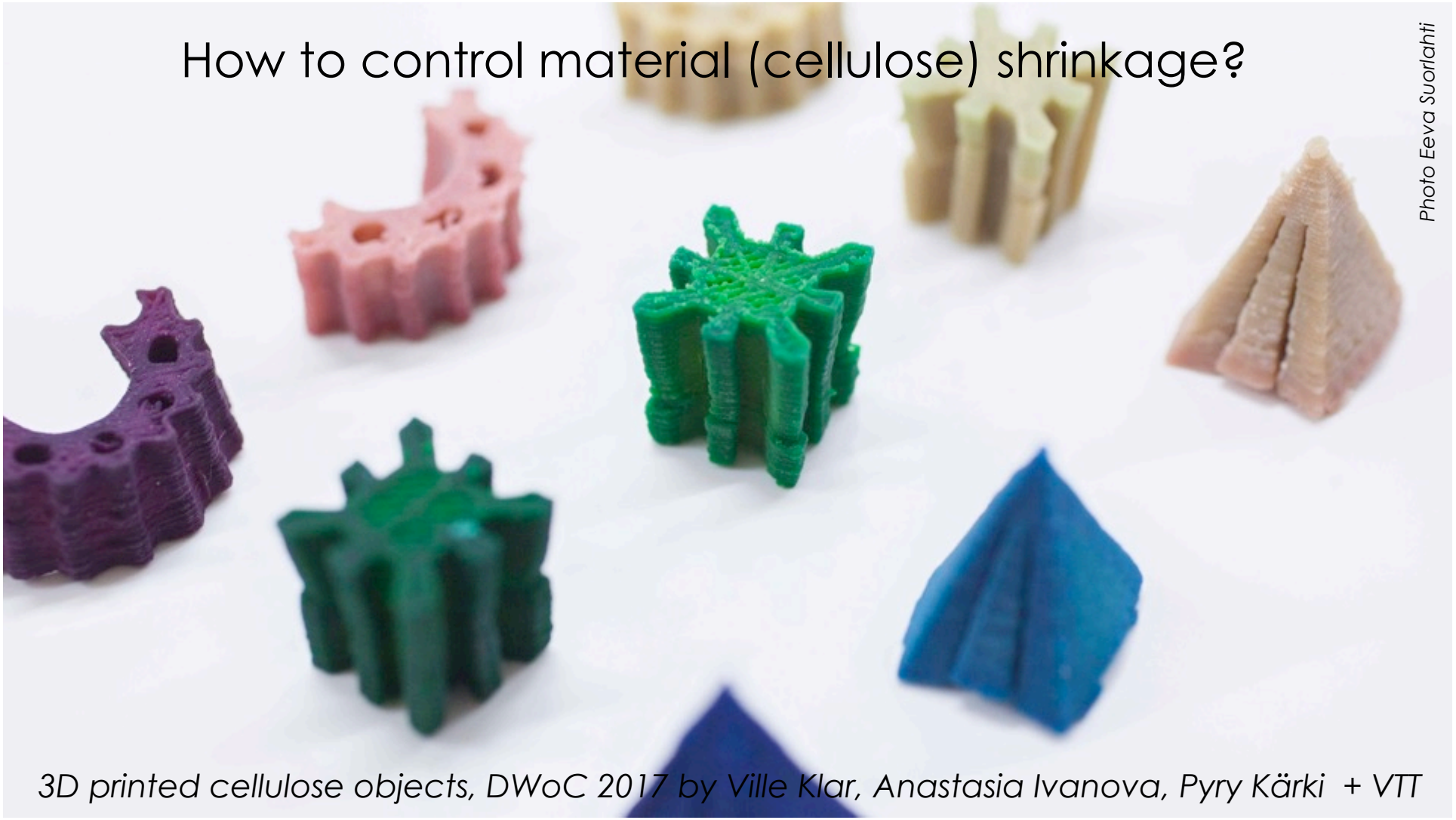


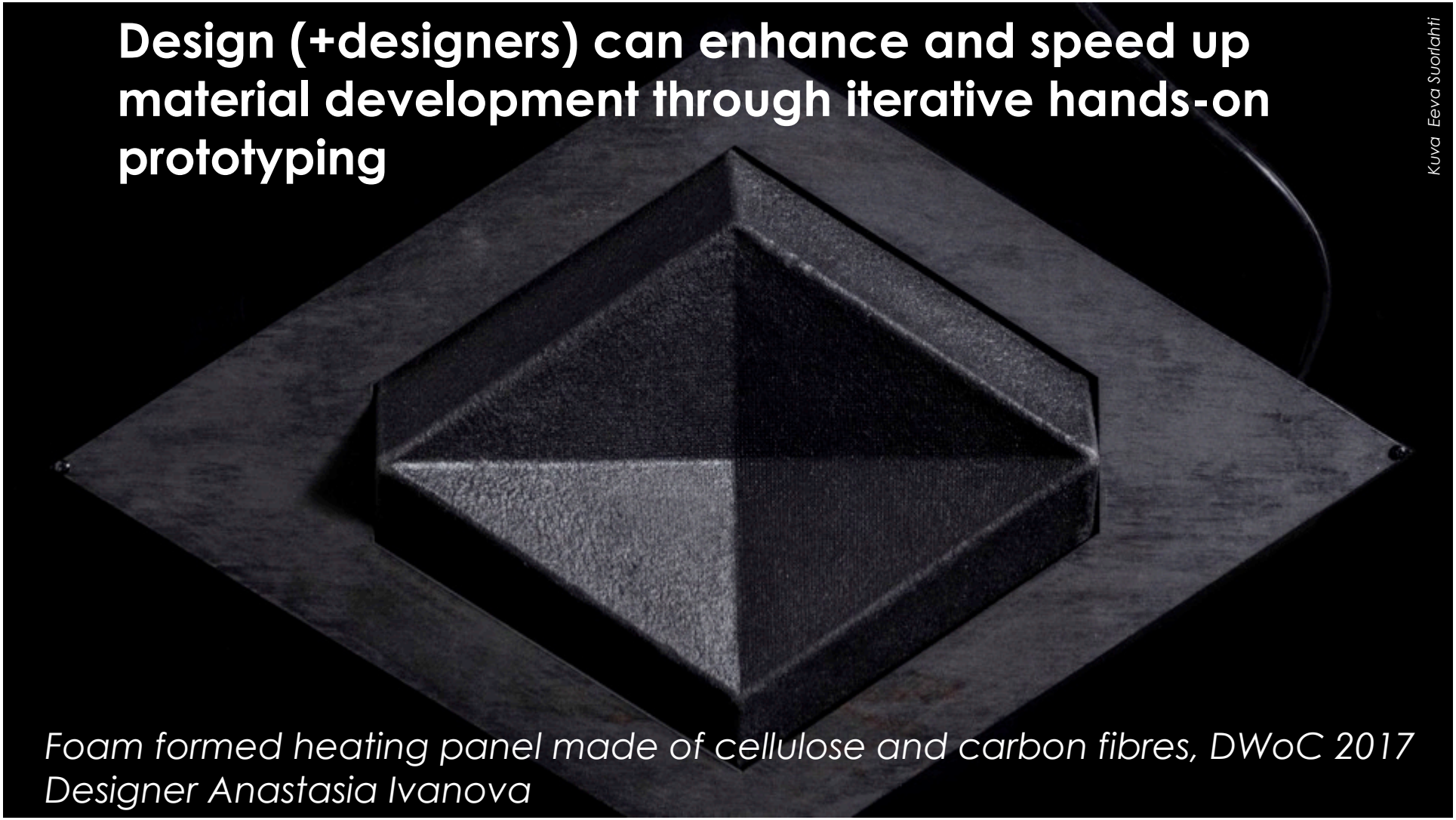
Photo Eeva Suorlahti

3D printed cellulose objects, DWoC 2017 by Ville Klar, Anastasia Ivanova, Pyry Kärki + VTT

How to benefit from material (cellulose) shrinkage?

3D textiles DWoC 2017 by Ilona Damski, Ville Klar / Aalto University + VTT

Design (+designers) can enhance and speed up material development through iterative hands-on prototyping



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Foam formed heating panel made of cellulose and carbon fibres, DWoC 2017
Designer Anastasia Ivanova

Design is a great tool for communication

Kuva Eeva Suorlahti

In DWoC design researchers were

AGENT OF CHANGE: Embedding design, architecture and design thinking in traditional pulp and paper business

CATALYZER: Generating new design driven activities and ideas

DESIGNER: Exploiting the methods of explorative prototyping and concept development – always considering the user (BtoB, BtoC)

TREND FORECASTER & VISUALIZER: Exploring, documenting and visualizing scenarios of how materials could be used

CURATOR & COMMUNICATOR: Disseminating the project findings and results

FACILITATOR: Engaging and inspiring student society


Collaboration!

Our Recipe for Successful Collaboration

Pirjo Kääriäinen & Liisa Tervinen

This recipe is based on our personal experiences and on several discussions with colleagues who have been working in creative multidisciplinary teams. The ingredients are well tested and we can warmly recommend them. Feel free to test portions and methods according to your own ideas and preferences.

FOR 2+ PEOPLE

Ingredients

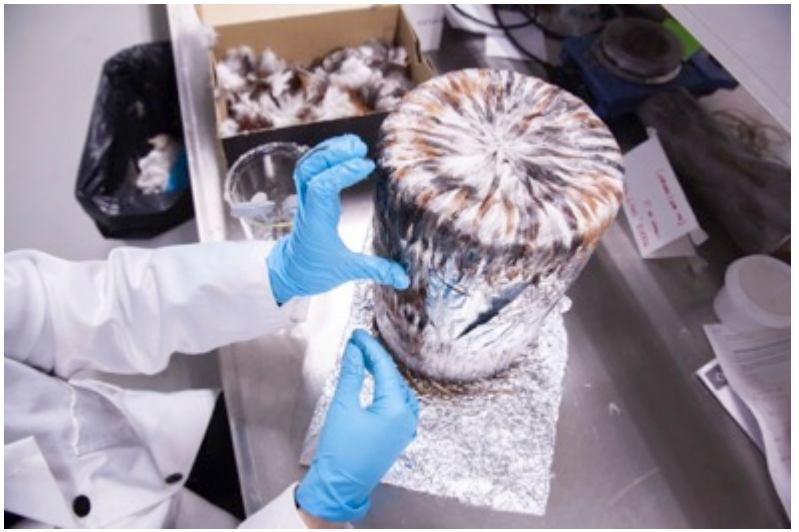
- A mix of open-minded people
  Try to find different species, preferably curious ones
- 1–2 inspiring encounters
- A bowl of support in the form of resources
- At least 10 portions of communication
- A handful of action & doing things together
- A large spoonful of courage
  Detailed maps can't be provided beforehand. To find something unseen, you have to explore and experiment. And fail.
- Lots of mutual respect and goodwill
- A Lot of Patience
- Add another 10 portions of communication to understand each other's language. *You can't have too much!*

Method

1. Enable inspiring encounters and let people find their shared interests. Stir if needed.
2. When the seeds of collaboration emerge, acknowledge them and let them grow. However, some of them might not survive – don't worry, you can try again. And not all of them will grow into anything at all.
3. Nurture promising seedlings carefully but not too much; they should have enough space and freedom to grow courageous and persistent.
4. Check that the collaboration is beneficial for all parties; it is equal and fair, talk and find a mutual agreement on IPR and acknowledgement.
5. Talk, talk and talk about the collaboration and process with each other. Then share it with others too as an inspiring unique story – your story.
6. Be proud of the journey and what has been achieved.
7. Repeat steps 1–5 until you are happy.
8. At its best, this all will lead into blooming, new, world changing and worth the effort.

LOST IN THE WOOD(S) Aalto ARTS Books 2017


'What becomes of the design process when working with living materials?
If we can turn a yeast into a living factory, what language will designers need to learn?
What are the ethical implications of biofabrication?'
Carole Collet



Experimenting with waste:

Dog hair
Cat tail (plant)
Chicken feathers
Saw dust
Nanocellulose
Potatoes
Starch
Coffee grains
…what else?

Photos Eeva Suorlahti

Thank you!

Courses:
Design Meets Biomaterials
CHEMARTS Summer School
UWAS Diving into Fashion Technologies
Bio Materiality (partly)

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