Zellulotische Materialgestaltung

—

zwischen
Naturwissenschaft und Design

Netzwerkveranstaltung Bioökonomie
Emmenbrücke, 10.01.2024
Meri Zirkelbach

VISCOSE EMMENBRÜCKE

HSLU

Überblick

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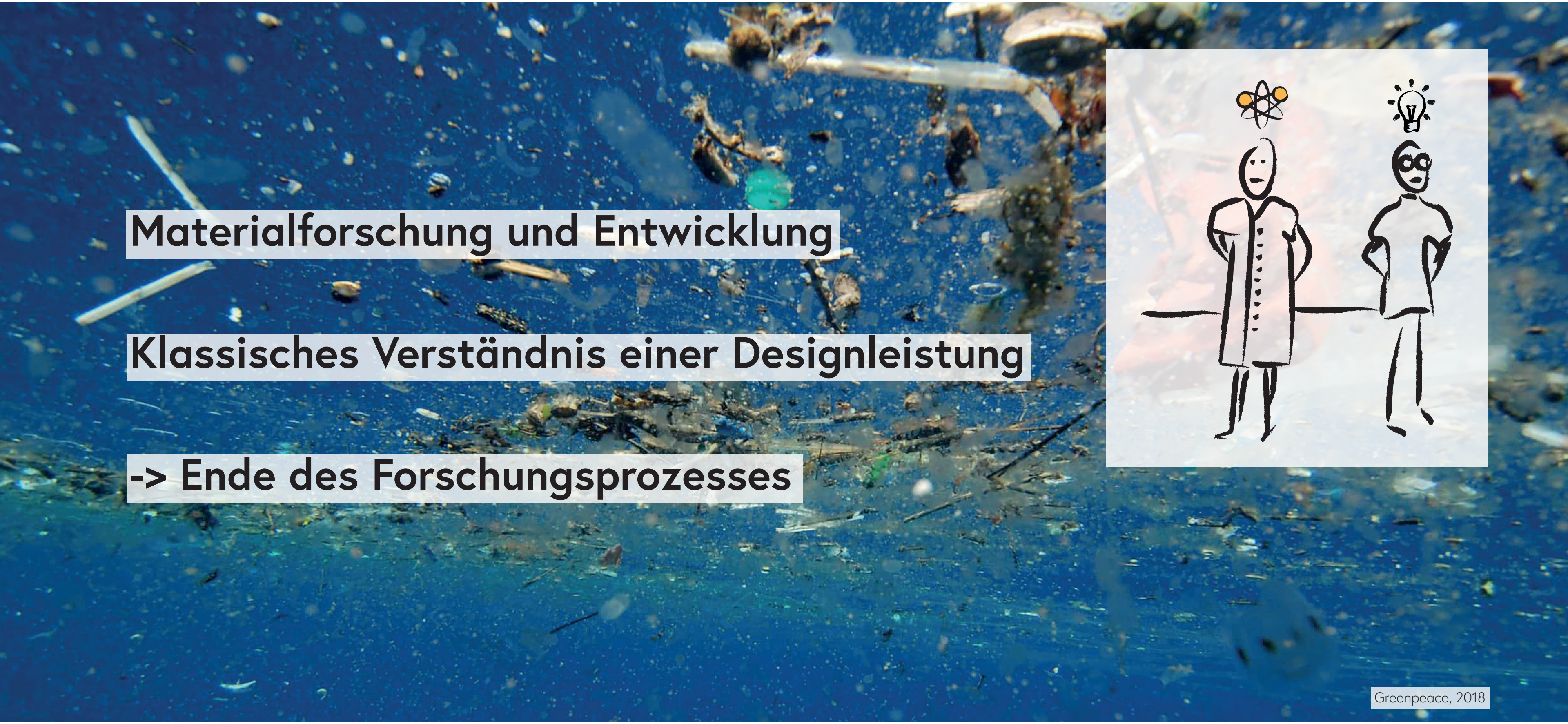
2. Persönliche Projekte
3. Lehre HSLU MAD
4. Ausblick

1. Relevanz

1. Relevanz



Materialforschung und Entwicklung

Klassisches Verständnis einer Designleistung

-> Ende des Forschungsprozesses

Greenpeace, 2018

1. Relevanz

Vielfältige Bereiche von Designinterventionen

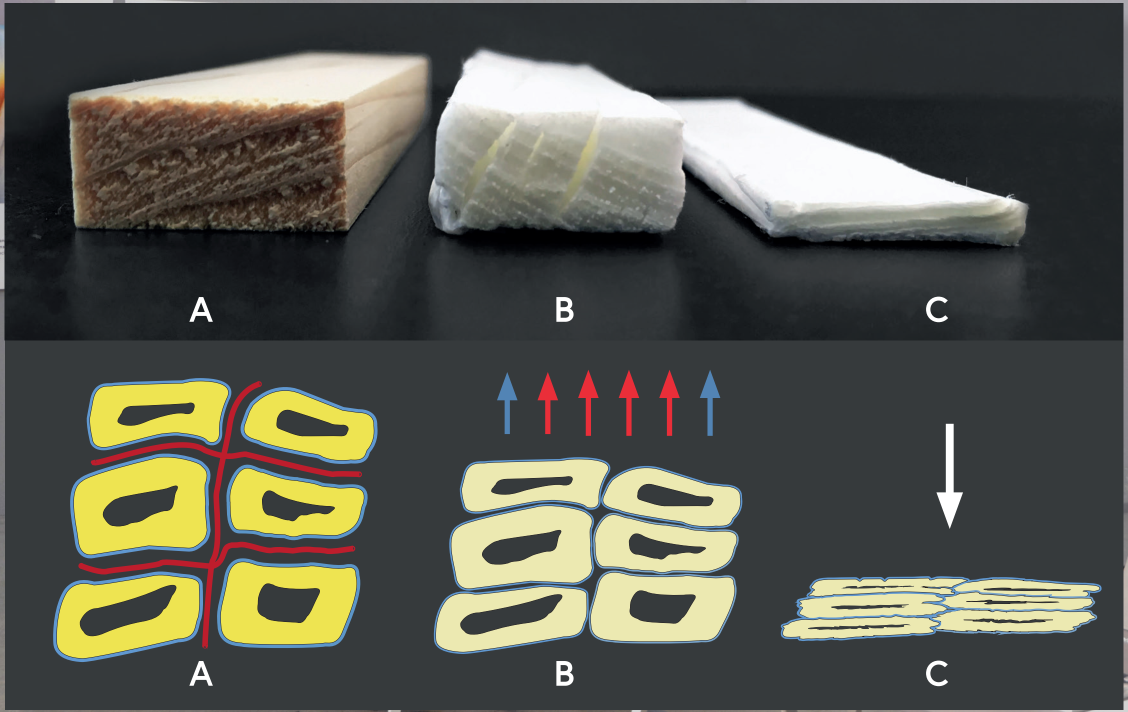
-> Ganzheitliches Verständnis einer Innovation

Greenpeace, 2018

2. Persönliche Projekte

MA Design, WhiteWood, 2019.

2. Persönliche Projekte



Materialveränderung Holz durch Delignifizierung und Verdichtung, eigene Abbildung.

2. Persönliche Projekte

Verformung in nassem Zustand und Hydrophobierung, eigene Abbildung.

2. Persönliche Projekte

Vorschlag zur Zusammenarbeit, eigene Darstellung

2. Persönliche Projekte

Gestalterische Potenziale Werkstoffkonzept, eigene Abbildung.

2. Persönliche Projekte

Möglichkeiten für die Automobilbranche, eigene Abbildung.

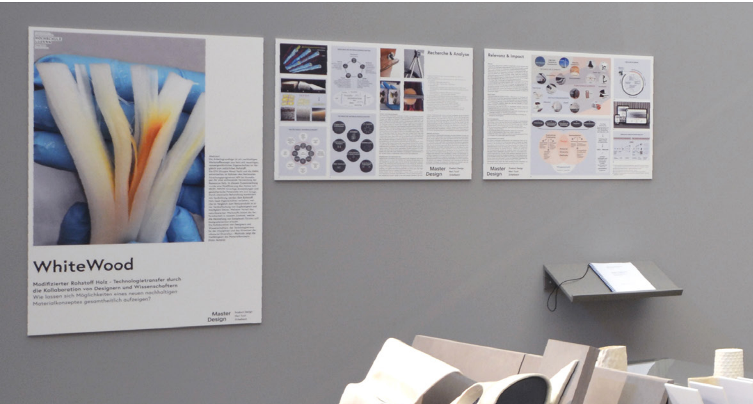
2. Persönliche Projekte

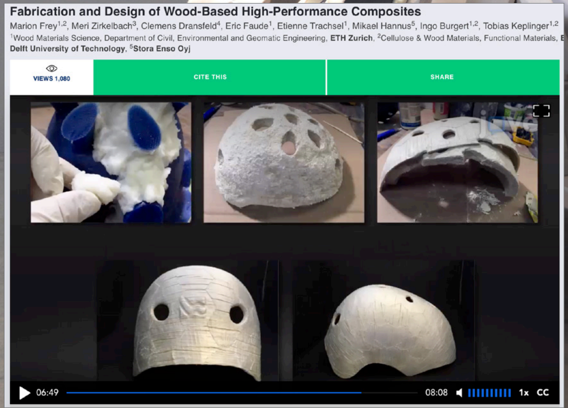
Transluszenz und Rohrstrukturen Wekstoffkonzept, eigene Abbildung.

2. Persönliche Projekte

Kombination Materialaspekte und dreidimensionale Formen, eigene Abbildung.

2. Persönliche Projekte





Jove, 2019

COMMUNICATION

ADVANCED SCIENCE

Tunable Wood

www.advancedscience.com

Tunable Wood by Reversible Interlocking and Bioinspired Mechanical Gradients

Marion Frey, Giulia Biffi, Maria Adobes-Vidal, Meri Zirkelbach, Yaru Wang, Kunkun Tu, Ann M. Hirt, Kunal Masania, Ingo Burgert, and Tobias Keplinger**

Elegant design principles in biological materials such as stiffness gradients or sophisticated interfaces provide ingenious solutions for an efficient improvement of their mechanical properties. When materials such as wood are directly used in high-performance applications, it is not possible to entirely profit from these optimizations because stiffness alterations and fiber alignment of the natural material are not designed for the desired application. In this work, wood is turned into a versatile engineering material by incorporating mechanical gradients and by locally adapting the fiber alignment, using a shaping mechanism enabled by reversible interlocks between wood cells. Delignification of the renewable resource wood, a subsequent topographic stacking of the cellulosic scaffolds, and a final densification allow fabrication of desired 3D shapes with tunable fiber architecture. Additionally, prior functionalization of the cellulose scaffolds allows for obtaining tunable functionality combined with mechanical gradients. Locally controllable elastic moduli between 5 and 35 GPa are obtained, inspired by the ability of trees to tailor their macro- and micro-structure. The versatility of this approach has significant relevance in the emerging field of high-performance materials from renewable resources.

Biological materials are able to optimize their structure[1,2] and chemical composition[3] to adapt to changing environmental conditions.[4] They can cope with external loading conditions by locally altering their stiffness, for example by adjusting the density,[2] the alignment of stiff reinforcing building blocks,[5,6] the chemical constituents,[3] or by interface design strategies.[7] Interfaces in biological materials can rely on structure or chemistry. In the example of wood, the interface properties between stiff cellulose fibrils and the soft matrix are determined by a multitude of weak chemical bonds,[8] whereas in the beak of the red-bellied woodpecker[9] or in the osteoderms of a leatherback sea turtle shell, jigsaw-like or sutured patterned interfaces lead to stress transfer or enable deformation.[10]

The efficient design of biological materials comprising hierarchical structuring, gradients, functionality, and specific interface structures has been role model for the development of bioinspired materials.[11] Although various bottom-up approaches have shown the potential of assembling building blocks to transfer bioinspired design principles into synthetic materials,[12] it still remains challenging to reach the structural complexity of biological materials and to fabricate them in an environmentally-friendly and scalable manner.[4] In contrast, when biological materials such as wood are used in top-down approaches, their hierarchical structure can be retained and modified.[13] A top-down wood modification approach gaining increasing attention is the delignification of wood by a

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Date	
	11.09.19

Reference	Application No./Patent No.
	19187447.8 - 1018
Applicant/Proprietor ETH Zürich	

Designation as inventor - communication under Rule 19(3) EPC

You have been designated as inventor in the above-mentioned European patent application. Below you will find the data contained in the designation of inventor and further data mentioned in Rule 143(1) EPC:

DATE OF FILING	: 19.07.19
PRIORITY	: //
TITLE	: SHAPE FORMING OF DELIGNIFIED WOOD
DESIGNATED STATES	: AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

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DECLARATION UNDER ARTICLE 81 EPC:
The applicant(s) has (have) acquired the right to the European patent as employer(s).

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EPO Form 1048 10.09 page 1 of 1

Technisches Patent, 2019

2. Persönliche Projekte

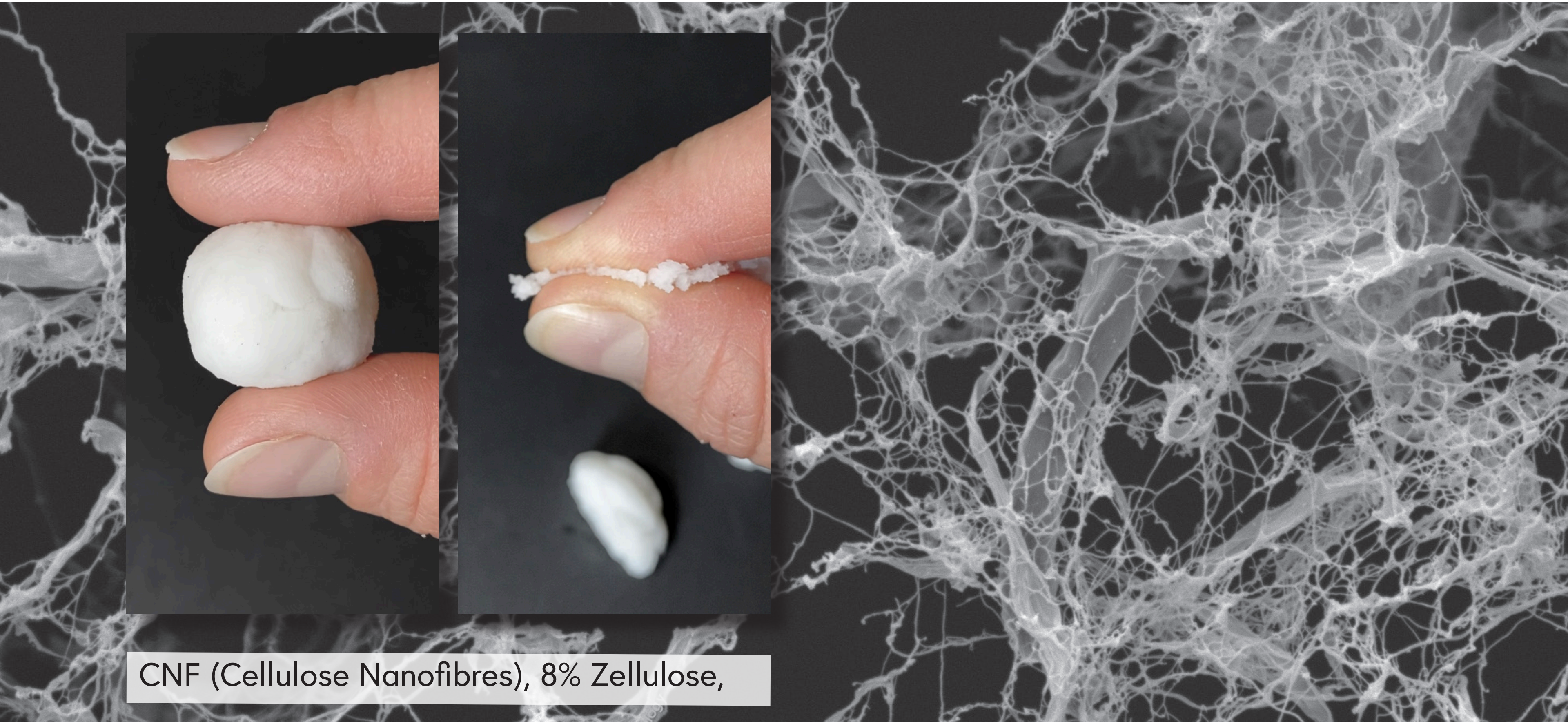
Materialspekulation

– Zusammenspiel von Materialtradition und materialorientierter Gestaltung

In Zusammenarbeit mit HfG Offenbach / Empa Dübendorf

Mikrofibrilläre Struktur von CNF, Empa 2022

2. Persönliche Projekte

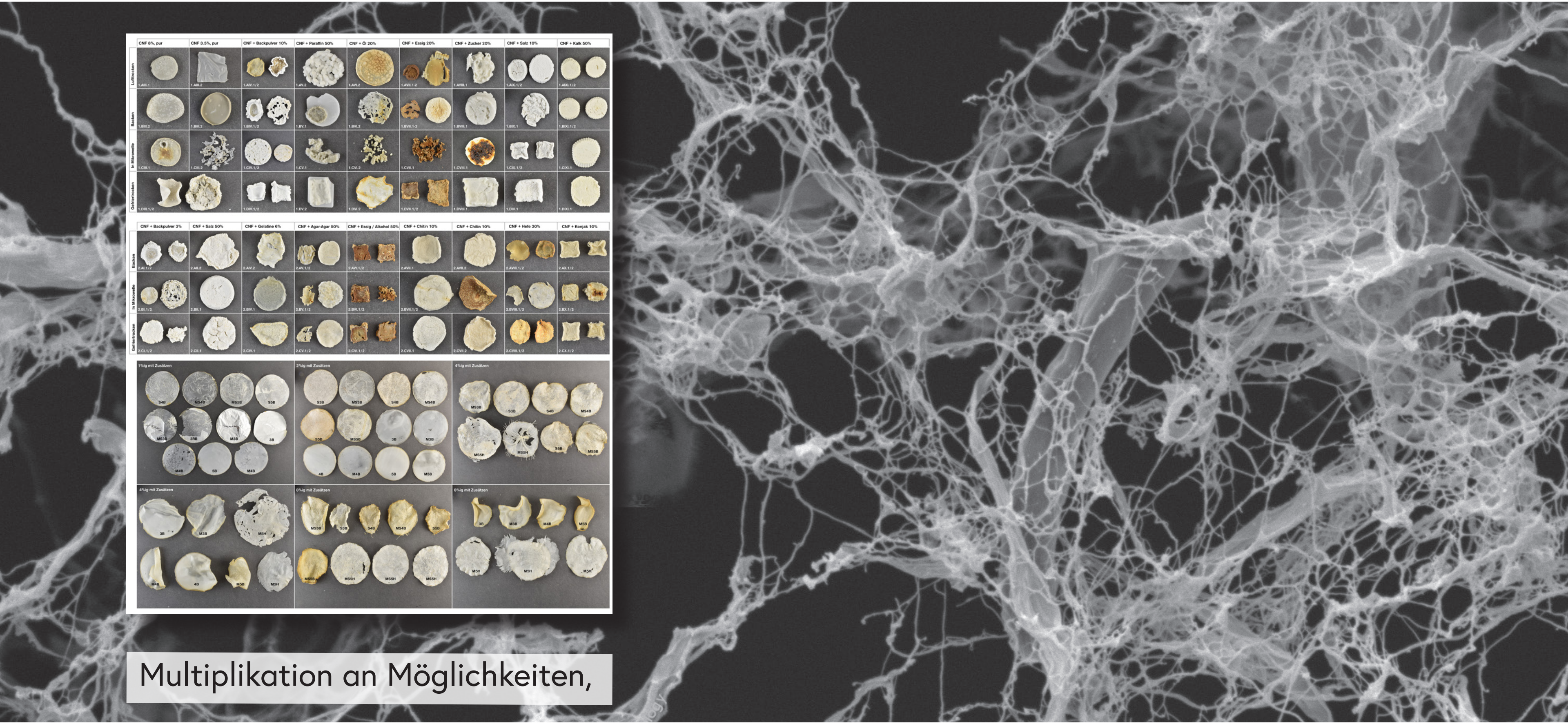


CNF (Cellulose Nanofibres), 8% Zellulose,

2. Persönliche Projekte

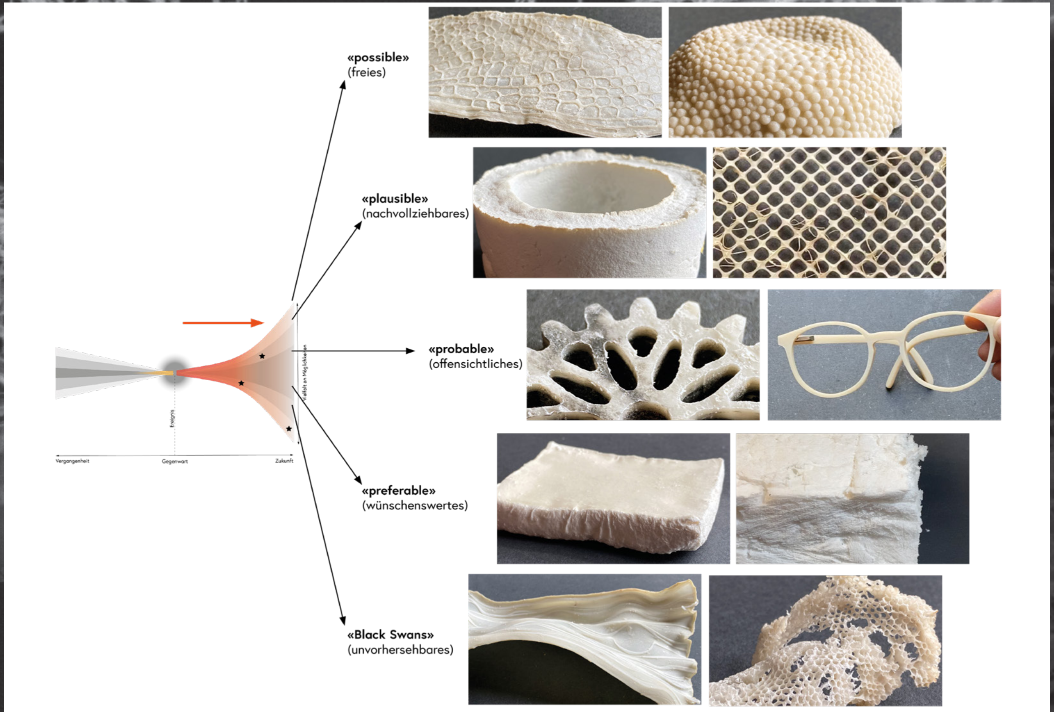
CNF (Cellulose Nanofibres), 8% Zellulose, Hornifiziert – Schaum, eigene Abbildungen.

2. Persönliche Projekte



Multiplikation an Möglichkeiten,

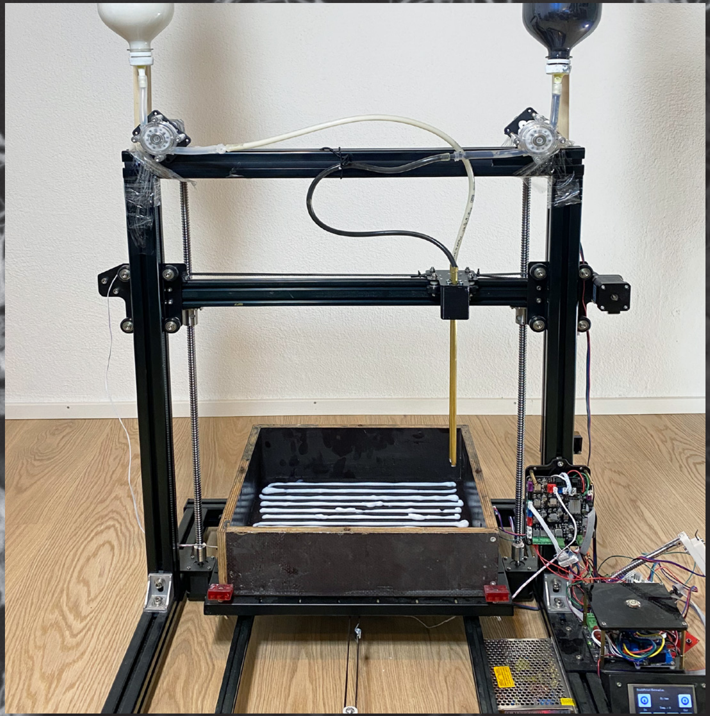
2. Persönliche Projekte



Multiplikation an Möglichkeiten,

Einordnung zukünftige Möglichkeiten, eigene Abbildungen.

2. Persönliche Projekte



Mittels 3D-Drucker gestaltetes und personalisierbares Material, eigene Abbildungen.

3. Lehre HSLU MAD

MaterioLab 2024, eigene Abbildung

3. Lehre HSLU MAD

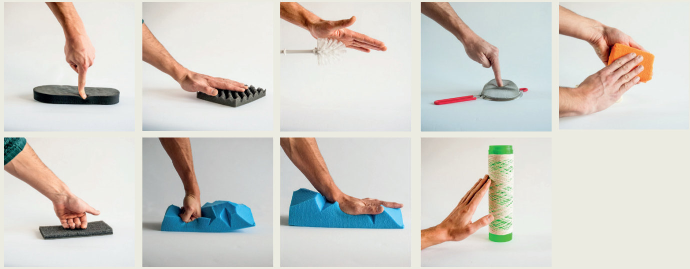
1. PERFORMATIVE LEVEL

What does the material make you do?

2 →

How do you touch the material?

- pressing
- rubbing
- grazing
- compressing
- poking
- caressing
- fiddling
- pounding
- pushing
- ....



How do you move the material?

- folding
- lifting
- weighing
- bending
- flexing
- picking
- squeezing
- smelling

How do you hold the material

- holding
- seizing
- pinching
- grabbing
- grasping
- ....

2. SENSORIAL LEVEL

3 →

How would you describe the material?

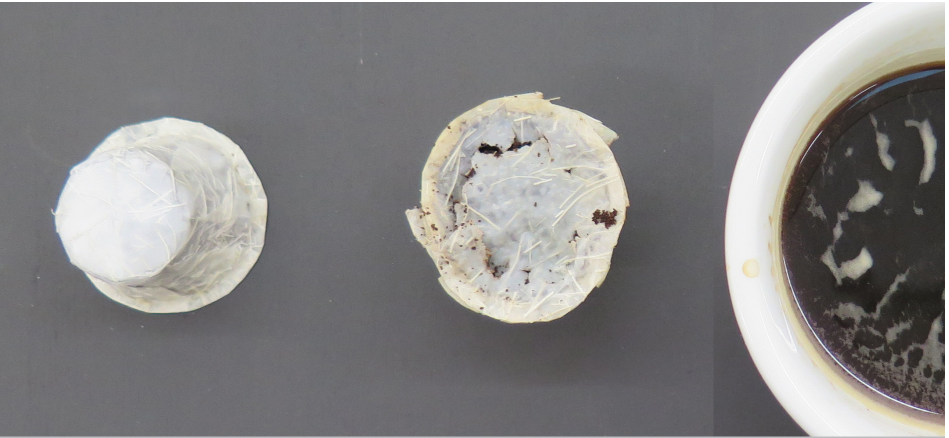
	-2	-1	0	1	2	
hard	o	o	o	o	o	soft
smooth	o	o	o	o	o	rough
matte	o	o	o	o	o	glossy
not reflective	o	o	o	o	o	reflective
cold	o	o	o	o	o	warm
not elastic	o	o	o	o	o	elastic
opaque	o	o	o	o	o	transparent
tough	o	o	o	o	o	ductile
strong	o	o	o	o	o	weak
light	o	o	o	o	o	heavy
regular texture	o	o	o	o	o	irregular texture
fibred	o	o	o	o	o	not-fibred

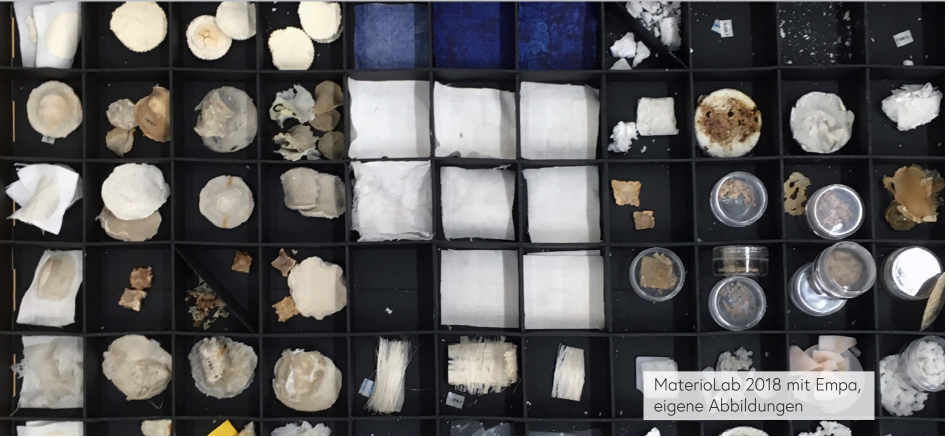
Camere & Karana, 2018

3. Lehre HSLU MAD

MaterioLab 2022 mit Empa, eigene Abbildung

3. Lehre HSLU MAD

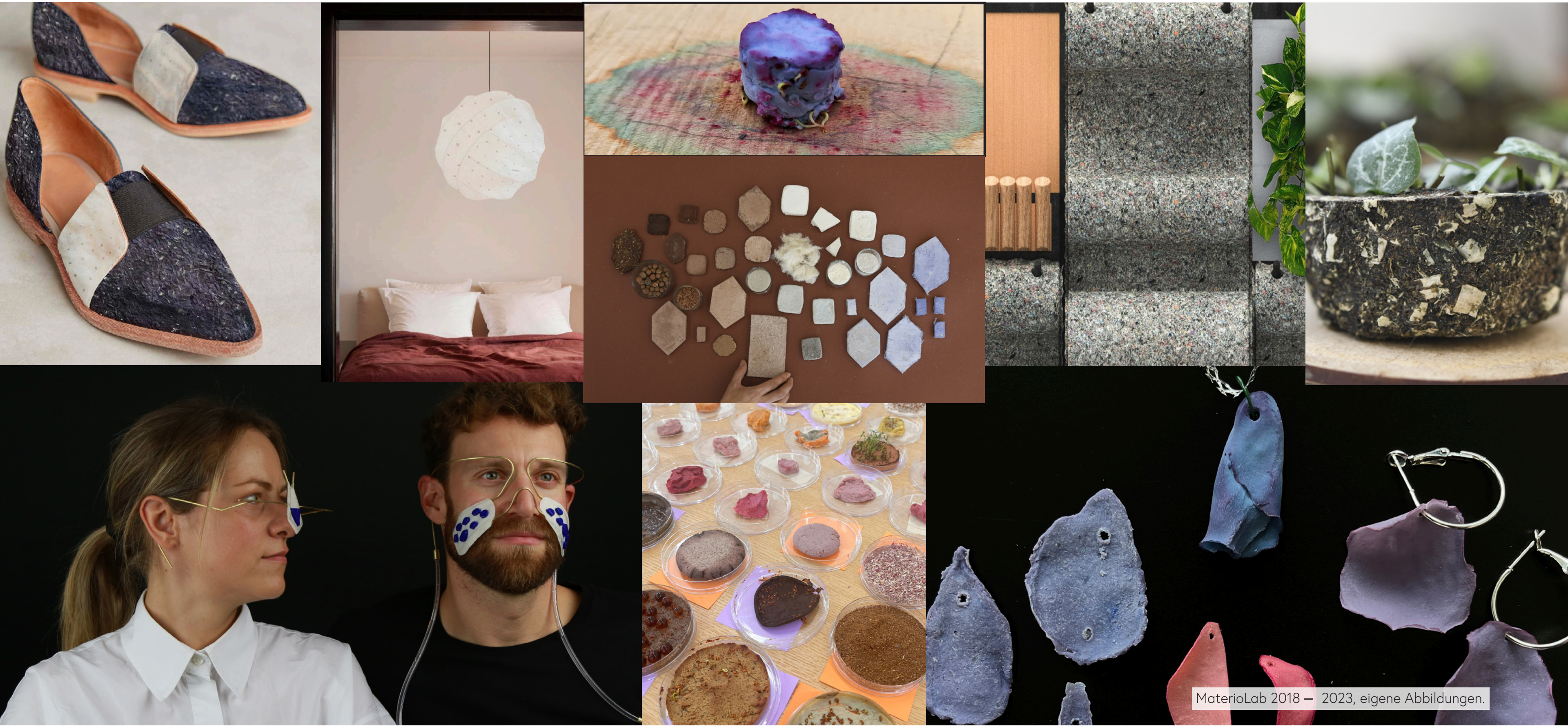




MaterioLab 2018 mit Empa, eigene Abbildungen

MaterioLab 2019 mit BASF, eigene Abbildungen

4. Ausblick



MaterioLab 2018 – 2023, eigene Abbildungen.

DANK

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