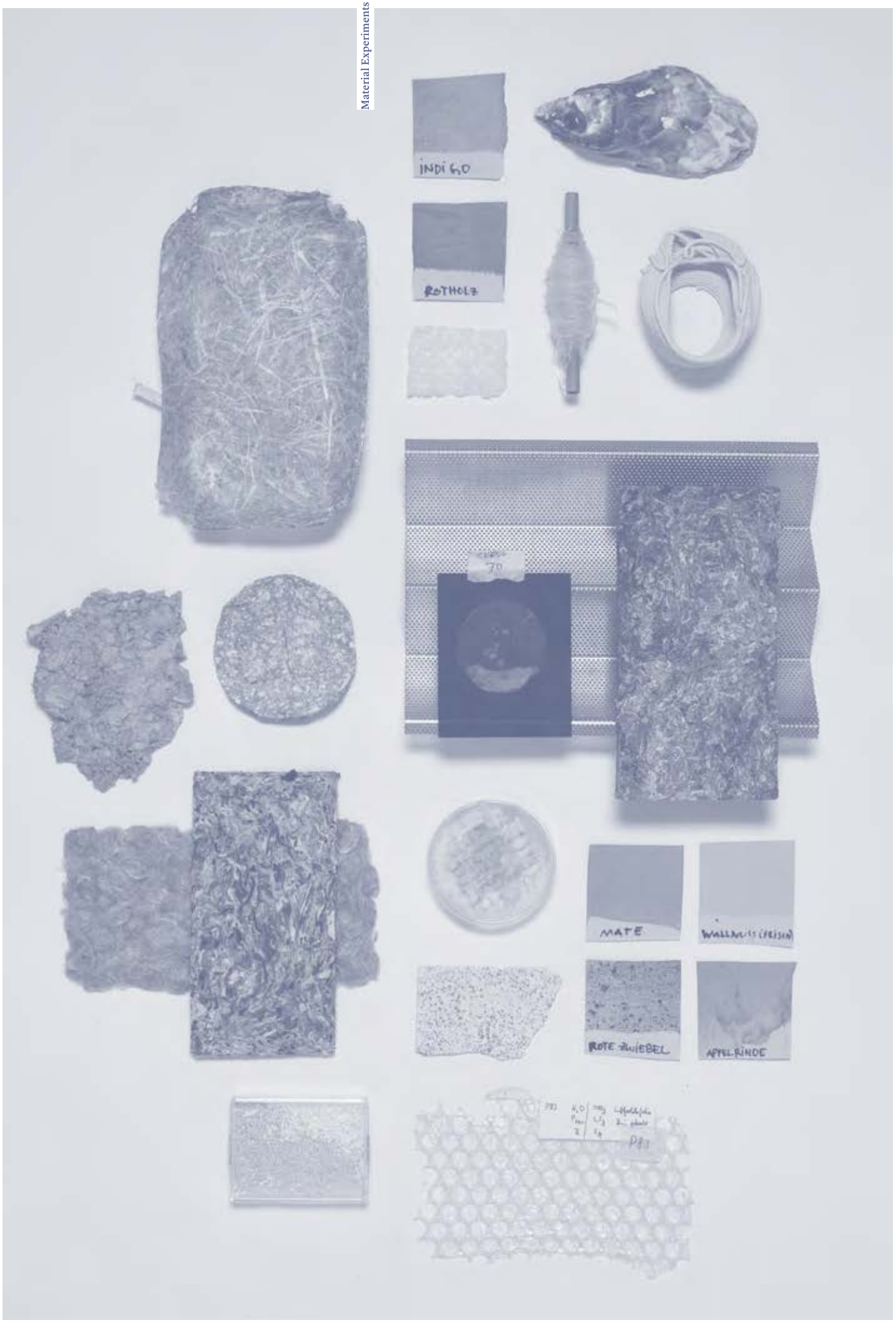
green lab

LABORATORY
FOR SUSTAINABLE
DESIGN STRATEGIES

GreenDesign[7.0]

material cycles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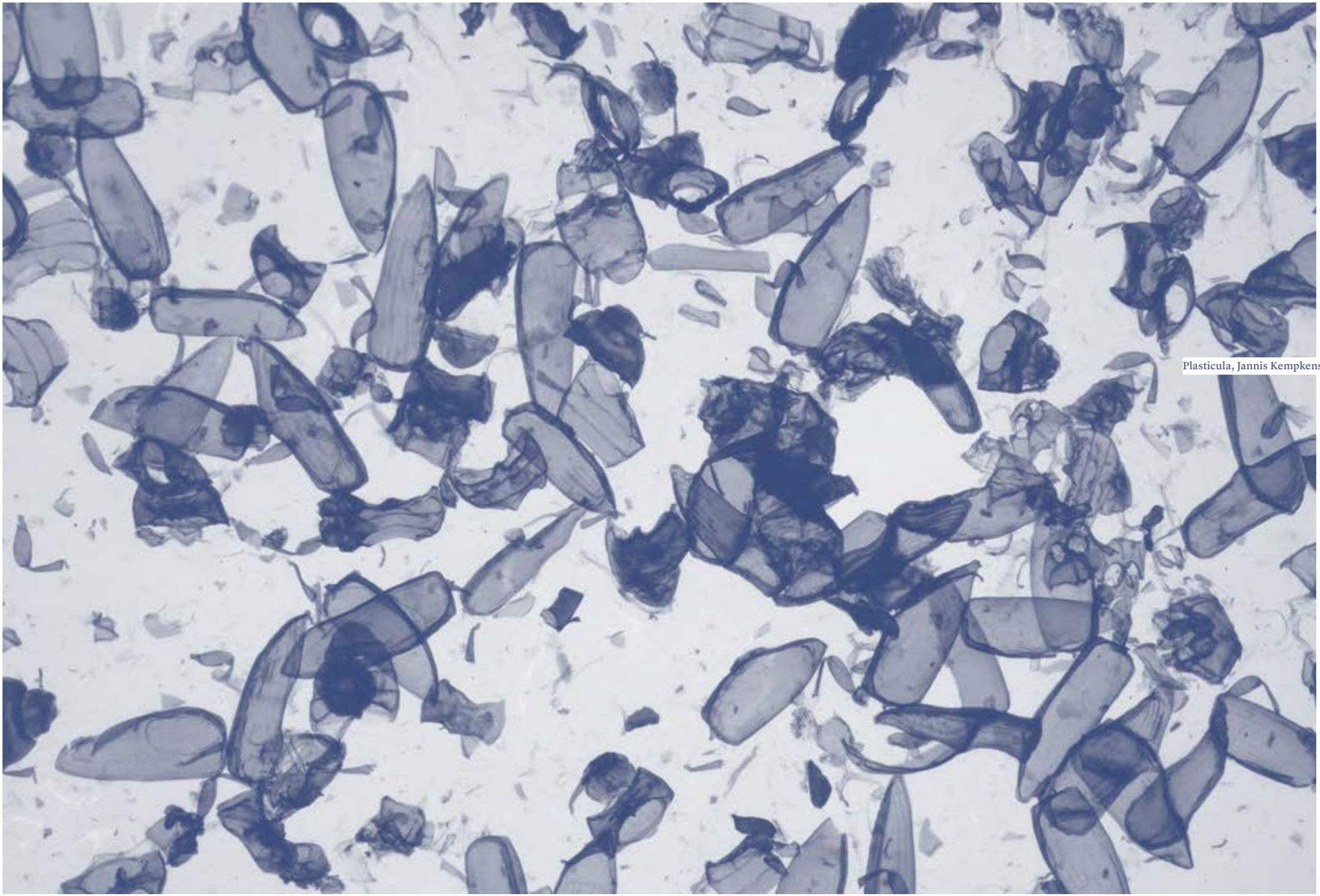
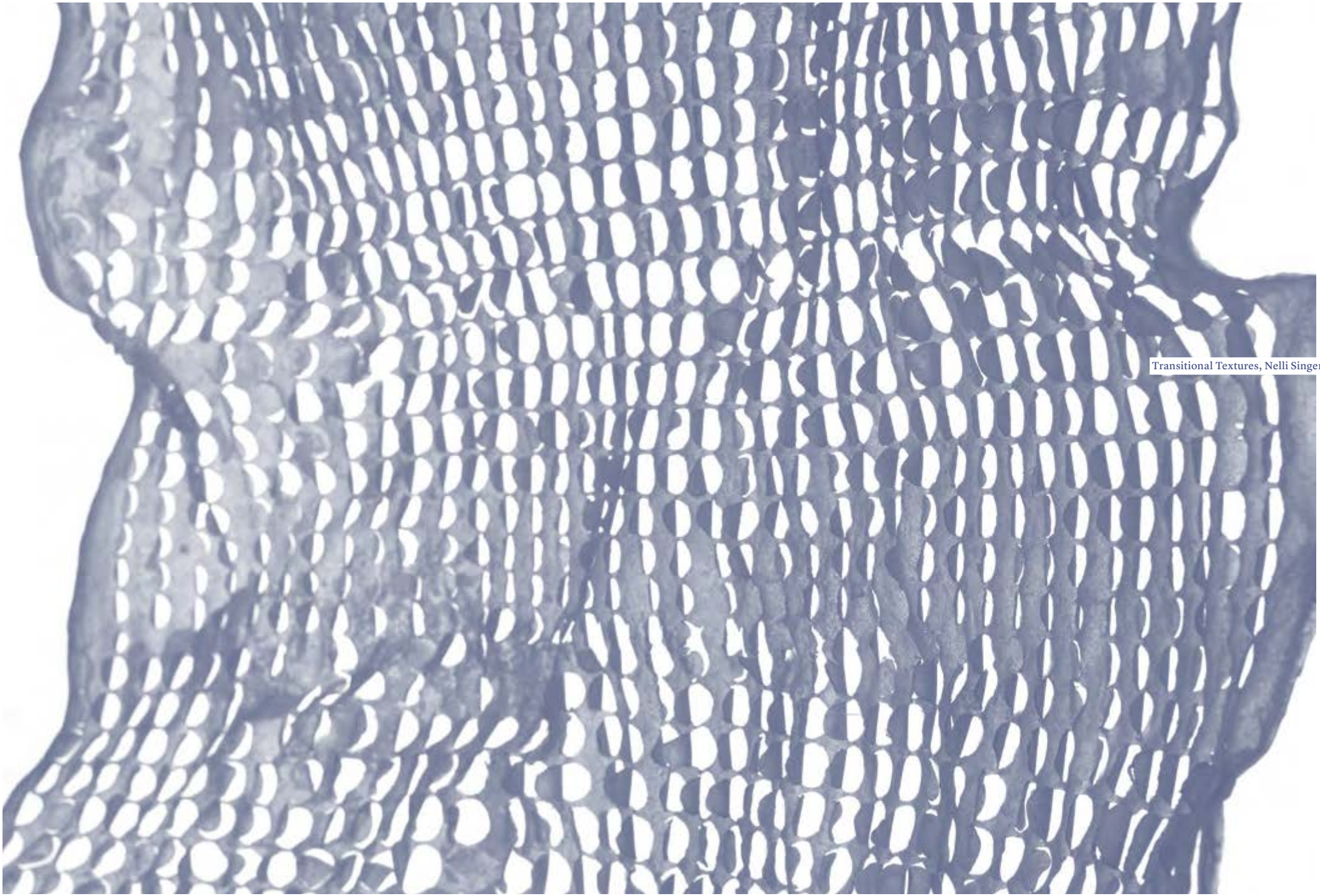
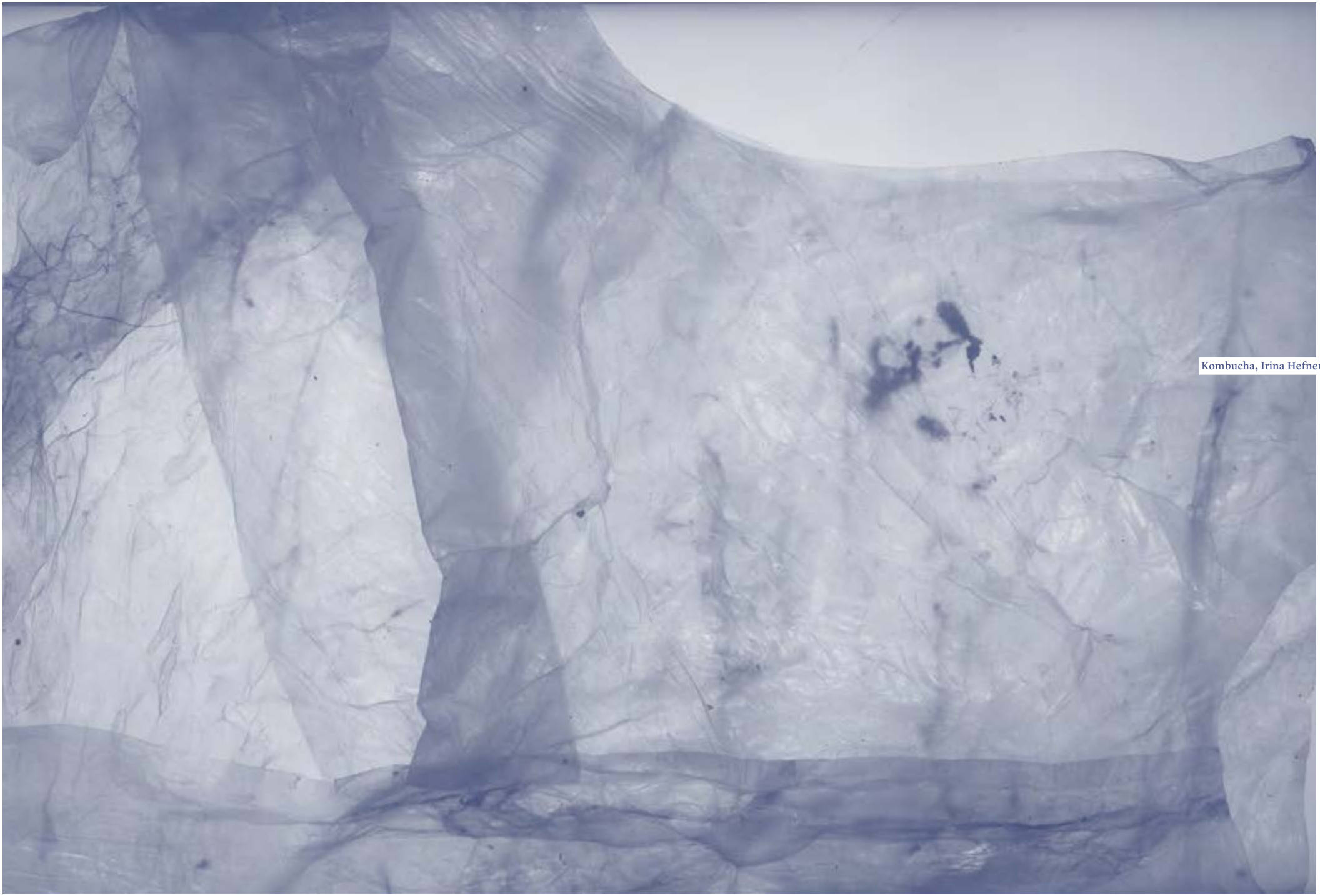


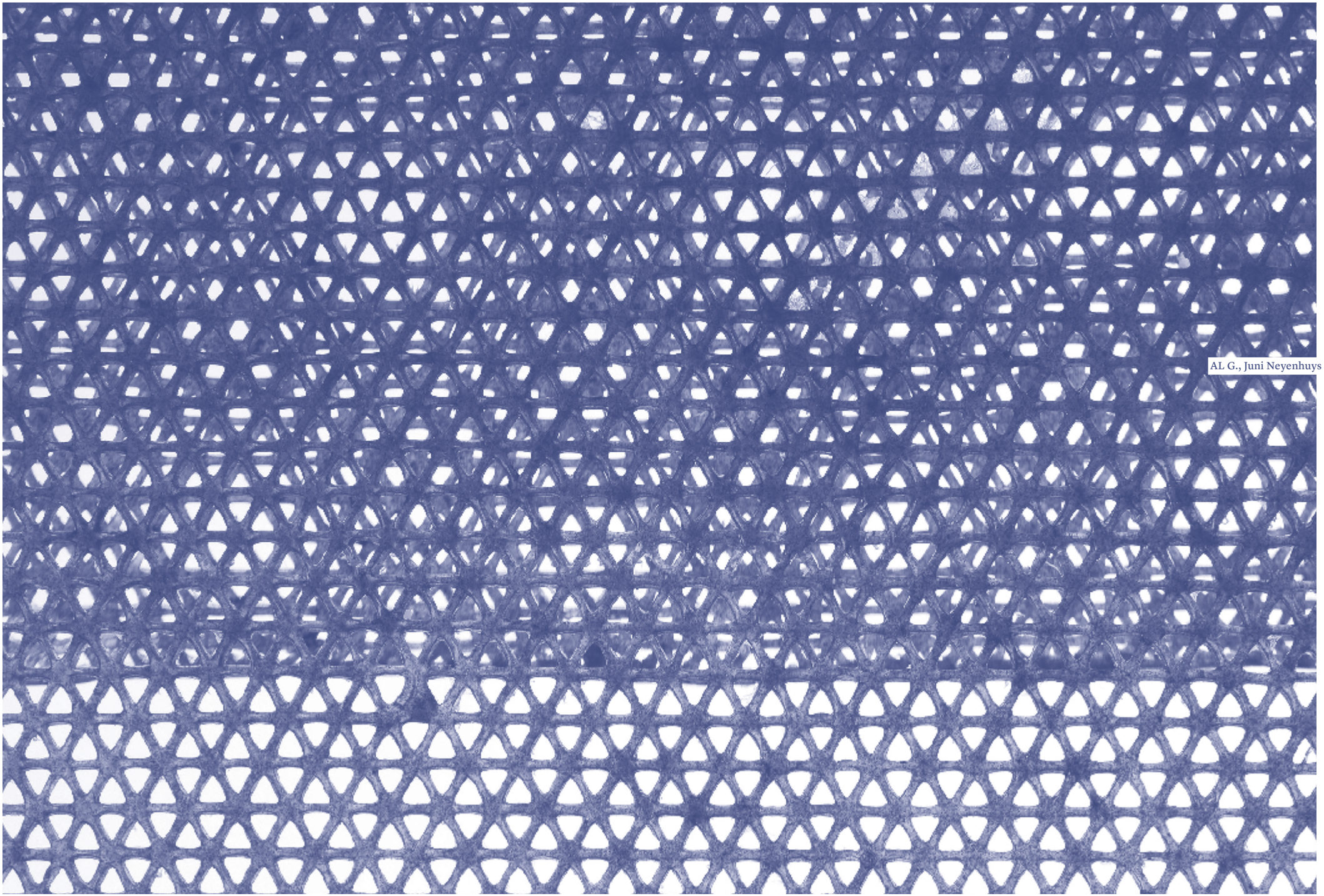
Plasticula, Jannis Kempkens

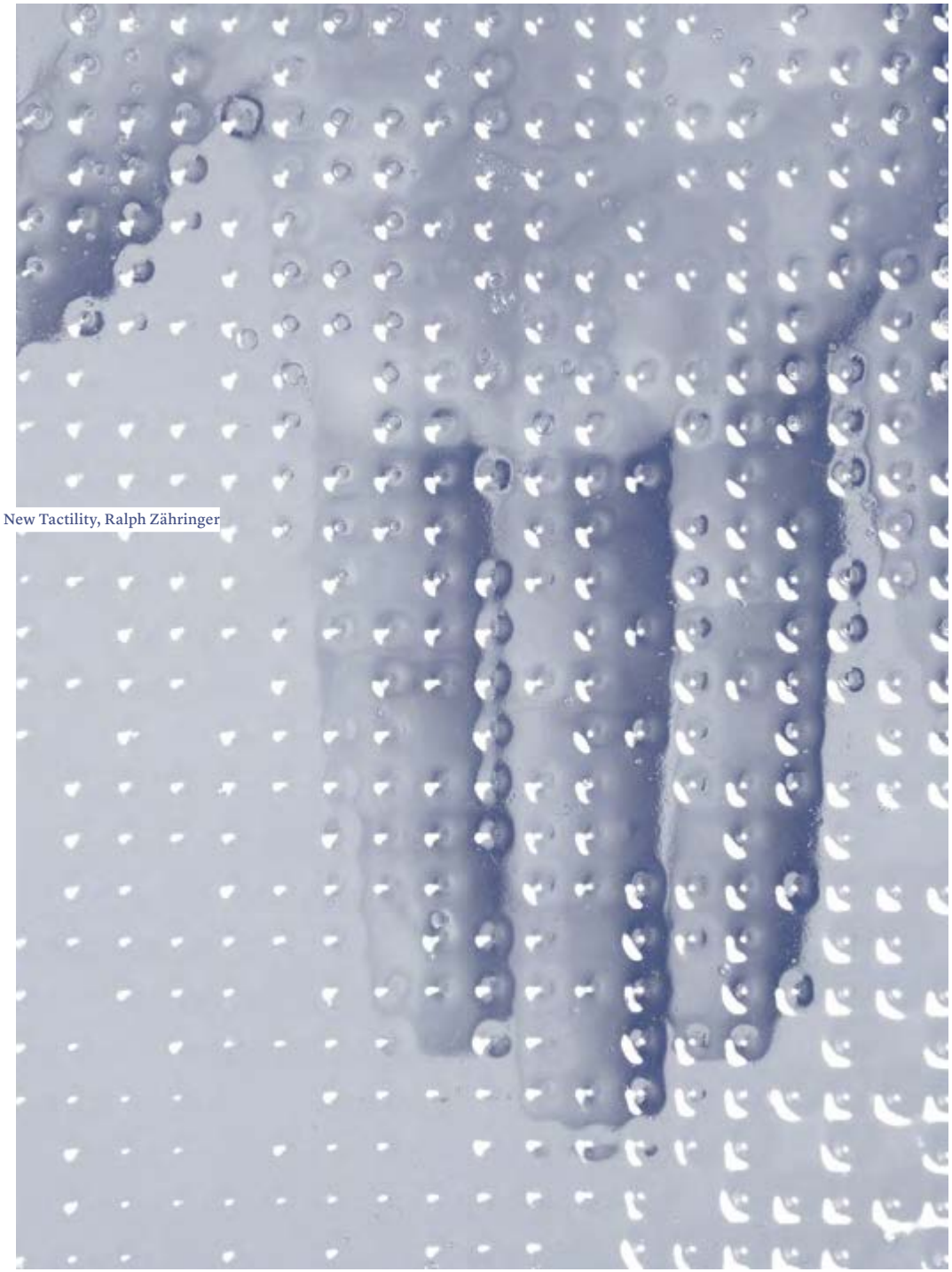


Transitional Textures, Nelli Singer



Kombucha, Irina Hefner


AL G., Juni Neyenhuys



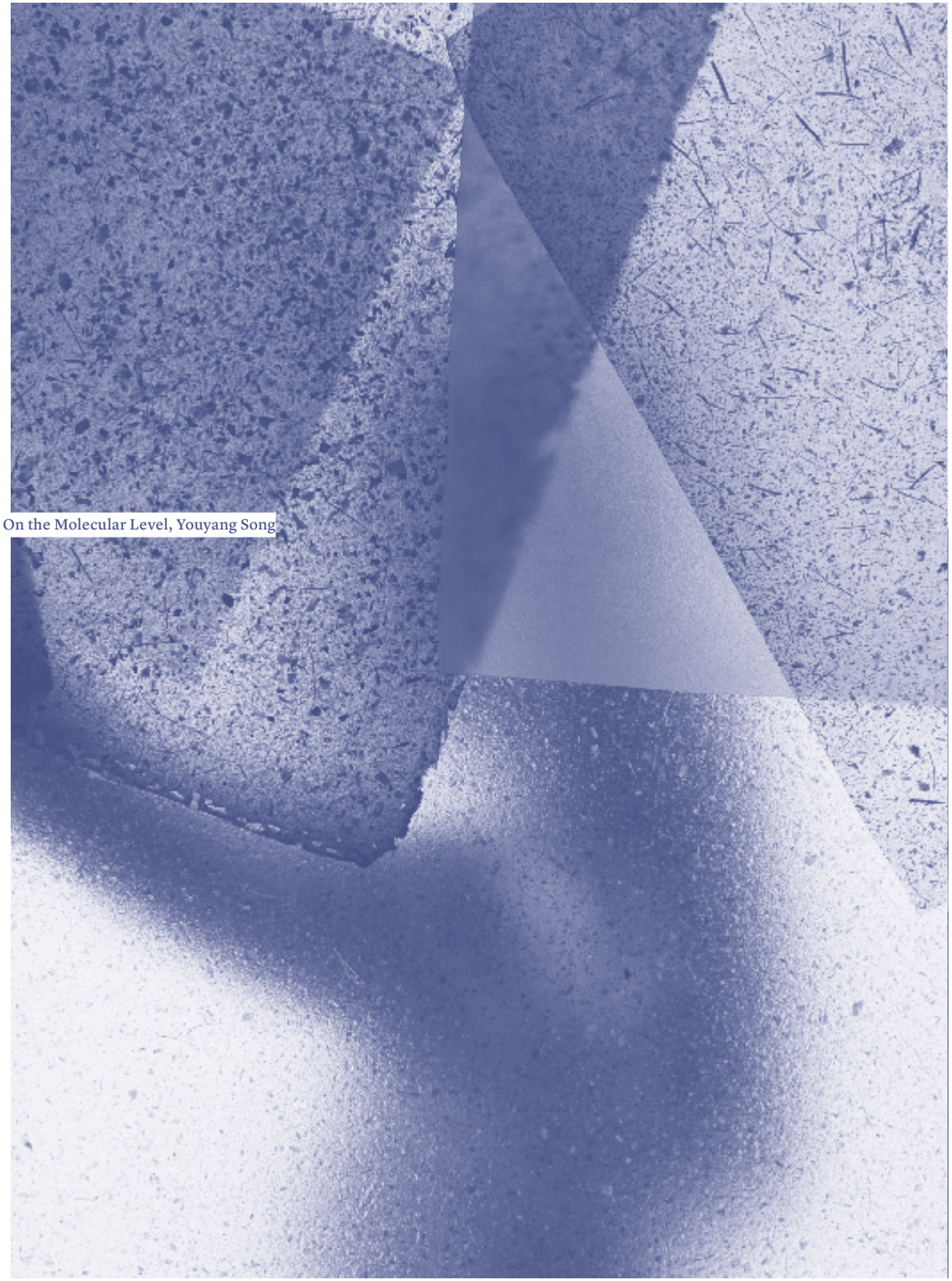
New Tactility, Ralph Zähringer

Content

GreenDesign[7.0]

material cycles

Introduction



On the Molecular Level, Youyang Song

GreenDesign 7.0 - Material Cycles
Introduction

Our finite natural resources such as oil, coal, natural gas, metals, and minerals are diminishing, while the pressure on water and other organic resources continues to grow. How can we change the way we design, produce, consume, and discard materials in order to live within planetary boundaries?

During the summer semester 2018, *greenlab* focused on strategies that address the informed choice and application of materials within the context of design for sustainability. Participants of the project, students selected from the departments of Product Design, Textile and Surface Design, and Fashion Design at the weißensee kunsthochschule berlin, were encouraged to develop individual concepts, systems, prototypes and/or services by drawing on circular economy thinking.

In a symposium, in workshops and individual projects, greenlab explored opportunities afforded by natural and manmade materials, small-scale or industrial production methods, closed loop and open source systems, and the various scales of circularity from the local to the global. Cultural concepts – such as the difference between 'natural' and 'man-made'– were challenged by looking into the possibilities that new fields such as biotechnology offer us, in order to develop sustainable materials and products.

greenlab started the summer semester with the symposium 'Material Cycles' which took place on 13th of April 2018, and addressed critical issues and developments within the field of circular design[1].

Students received extensive information about concepts, strategies and practices regarding sustainability from the perspective of designers, technologists, and practitioners working in the areas of ecological design and the circular economy.

A focus was set on innovative concepts and practices and on the social and economic potential of sustainable and ecologically sound production methods, their potential impact on our everyday lives, and the role of design and designers within this context.

The symposium addressed five sub-themes:

- material choices - natural and man-made – their origins and impact during material lifecycles of use and disposal;
- state-of-the-art strategies for circular design: the creation, production and use of products, through design case studies;
- various scales of circularity from the local to the global;
- closed loop, circular flows and open source systems;
- visions and new developments with a particular focus on possibilities offered by biotechnology.

[1] The full symposium programme can be viewed on pages 35 - 43

The Material Cycles speakers*

Dr. Kat Austen
University of Leeds
Dr. Flavia Barragan
topLab, Berlin
Prof. Aart van Bezooijen
University of Art and Design Halle
& Founder Material Stories, Hamburg
Johann Bödecker
CEO Pentatonic GmbH, Berlin
Dr. Kirsten Brodde
Greenpeace Germany
Prof. Dr. Alberto T. Estevez
Director, Institute for Biodigital
Architecture & Genetics, Barcelona
Dr. Holger Fischer
Fiber and Material Development,
Faserinstitut Bremen e.V. - FIBRE
Essi-Johanna Glomb
Founder Studio Blond & Bieber, Berlin
Lilith Habisreutinger
weißensee kunsthochschule berlin
Jonathan Minchin
IAAC/Valldaura Labs, Barcelona & London
Ulrike Niesmann
Senior Project Manager, EPEA Environmental
Protection Encouragement Agency, Hamburg
Prof. Dr. Lucy Norris
weißensee kunsthochschule berlin
Dr. Arndt Pechstein
phi360 Innovation &
Hasso-Plattner-Institut, Berlin

Anastasia Pistofidou
Founder FabTextiles und
Textile Academy, Barcelona
Björn Schlingmann
Engineering Lead Mini-wiz
Europe GmbH, Berlin
Annette Schmid
Ronnenberg Creative Technology,
Hamburg & London
Frieder Söling
Office for Energy, Environment and
Innovation - Berliner Stadtreinigung BSR
Sophie Thomas
Thomas.Matthews Communication Design,
London
Lars Zimmermann
OSCEdays, Berlin

Symposium, April 2018

* In the areas of sustainability, circular design and biodesign, in alphabetical order.

The symposium and strategic workshops, such as the *Sustainable Strategy Workshop* led by Dr. Rosie Hornbuckle and Dr. Dawn Ellam from the Centre for Circular Design, University of the Arts London, and the *Circular Economies* crash course with Prof. Dr. Lucy Norris, stimulated the design students from the various departments to apply problem-solving strategies developed through circular design thinking to their respective individual semester projects. The hands-on workshop *Grow your own Materials* at TopLab Berlin, led by chemist and bioscientist Dr. Flavia Barragan, the bioartist Fara Peluso, and designer Lisa Stohn, looked at the possibilities afforded by basic DIY biotechnologies exploring photosynthetic microalgae, bacterial cellulose and fungi, thus introducing the students to selected methods of biodesign. A one-day excursion to SOLAGA – a company specialising in solar biotechnologies – gave an insight into the work of an innovative biotech start-up. The workshop *Focus Papier* led by the acclaimed paper specialist and maker Gangolf Ulbricht investigated the paper-making techniques using local fibres. Another workshop – *3D Printing with Fluid Materials* – delivered by designer Babette Wiezorek, gave the students the opportunity to experiment with a wide range of unusual materials, including biopolymers, employing 3D printing techniques for form generation. And finally, the workshop *Introduction to Natural Dyes* by Anne Hederer gave interested students the knowledge and necessary skills to access a broad colour pallet consisting entirely of locally sourced pigments, both from plants and food waste.

The practice-based design project was accompanied by a strong theory element in the form of lectures delivered by Prof. Dr. Lucy Norris on circularity, placing materials within broader ecological, social and economic contexts, challenging the students to reflect on their own design practice and making. Topics included the historical development of concepts of sustainability and the circular economy, the bioeconomy and collective bio-citizenship, the politics of the circular economy and emerging textile technologies, new material ecologies and digital fabrication. Thinking about materials in flow changed the focus from a problem of resource scarcity to the opportunities of local abundance and the search for resources in unexpected locations such as local wastestreams. Students prepared group presentations on materials with which they were experimenting in their practice-based work, including bacterial cellulose, chitin, mycelium, algae, oyster shells and natural plant dyes.

We are very pleased to present the project outcomes in this publication. These projects were shown at the Open Days in July 2018 at weißensee kunsthochschule berlin and received enthusiastic feedback from experts in the fields of design and sustainability, as well as from the general public. Selected student projects have also been shown at several other international events and exhibitions, receiving special mentions. Here, to mention just a few:

- *Cooking New Materials* (Youyang Song) received the MATERIALICA Sustainable Technologies for New Mobility Student Award presented at the *eMove 360°* fair in Munich;
- *Epithel* (Thalea Schmalenberg), *Our Local Nettle* (Tau Pibernat), *Plasticula* (Jannis Kempkens) and *REwoodable* (Nicole Dietz, Esther Kaya Stögerer, Tilman Holz) were exhibited at the *New Standards* show at Bauhaus Dessau;
- *AL G. - Transformation of brown Algae* (Juni Sun Neyenhuys) and *REwoodable* (Nicole Dietz, Esther Kaya Stögerer, Tilman Holz) were showcased at the exhibition *Materials Culture* at the ORGATEC 2018 Fair in Cologne, highlighting changes in materials and work culture;
- *Epithel* (Thalea Schmalenberg) and *Cooking New Materials* (Youyang Song) are currently on the GREEN DESIGN AWARD 2019 shortlist;
- *AL G.* (Juni Sun Neyenhuys) and *Cooking New Materials* (Youyung Song) have been invited to show their material innovations at the exhibition *New Textile World* in 2019.
- *STATUS QUO* (Tim van der Loo) and *Cooking New Materials* (Youyang Song) are now being continued as MA graduation projects at weißensee kunsthochschule berlin. *AL G. – Transformation of brown Algae* (Juni Sun Neyenhuys) is being developed in collaboration with the Department of Polymer Technology and Polymer Physics at the Technical University Berlin, while the designers of *REwoodable* (Nicole Dietz, Esther Kaya Stögerer, Tilman Holz) will be presented at the *4. Innovationsakademie Lignocellulose* at Federal Institute for Materials Research and Testing (BAM).

We are looking forward to the further development of these projects together with experts from science and technology.

Team GreenDesign 7.0 - Material Cycles:
Prof. Dr. Zane Berzina Conceptual Development of Materials and Surfaces / Textile and Surface Design
Prof. Susanne Schwarz-Raacke Design and Sustainability / Product Design
Prof. Heike Selmer Conceptual Design/ Fashion Design
Prof. Dr. Lucy Norris Design Anthropology and Material Culture / Theory and History
Essi Johanna Glomb, MA Design Researcher/ Textile and Surface Design
Julia Wolf, Dipl. Des. Design Researcher/ Textile and Surface Design

Collaborating experts:
Dr. Flavia Barragan Chemist & Bioscientist, topLab Berlin
Anne Hederer Natural Dyes Expert, weißensee kunsthochschule berlin
Fara Peluso Bioartist
Lisa Stohn Designer & Funghi Expert
Gangolf Ulbricht Paper Making Expert
Babette Wiezorek Designer & Expert in 3D printing with fluid materials

Find out more about greenlab:
http://greenlab.kunsthochschule-berlin.de
http://www.kh-berlin.de/hochschule/forschung/greenlab.html

Natural dyeing workshop by Anne Hederer, June 2018

GreenDesign 7.0

circular thinking and sustainable materials & techniques

Workshops

Circular Thinking and Sustainable Materials & Techniques Workshops

Circular Design Thinking Workshop by
Dr. Rosie Hornbuckle & Dr. Dawn Ellams, April 2018

Circular Design Thinking Workshop
16.04. - 18.04.2018
Dr. Rosie Hornbuckle & Dr. Dawn Ellams

In order to design within the circular economy, designers need to look beyond the final product and understand the system in which the product is created and used.

The Centre for Circular Design (CCD) evolved from Textiles Environmental Design (TED) and is focused on design research for the Circular Economy through materials, models and mindsets.

The TEN is a tool developed by TED for designers to support the development of sustainable design for materials, processes, products and systems. During the Circular Design Thinking Workshop, strategies for circular materials, products, services and business models based on The TEN were developed. Material samples and completed research brought in by the participants were used to build material life cycles and to explore designing products for the circular economy.

Circular Economy Crash Course
19.04. - 20.04.2018
Prof. Dr. Lucy Norris

This two-day workshop combined an introductory lecture, a practical assignment and a group feedback session to introduce students to some fundamental concepts in environmental sustainability, and to explore research methods that open up the broader contexts in which materials and objects are created and exchanged.

The questions raised included: What are circular economies and how are materials being designed to cycle through different uses? Is waste 'a design flaw'? What is our relationship to the material world and how might it change as new materials, products and systems are developed? Which research methods are useful for understanding these relationships and how might they be integrated into design practice? Using the *chaîne opératoire* method for understanding processes, students were asked to research a simple everyday activity in depth on the first day, then visualise their results and communicate their analysis to the group on the second day.

Fokus Papier
23. - 24.04.2018
Gangolf Ulbricht
Papermaking Manufacture,
Kunstquartier Bethanien

In the human history of technology, paper-making is perhaps the first actual recycling process: A used product, which original purpose has been fulfilled, undergoes a process which transforms it into a new product with new properties, suitable for a new purpose. Traditionally, worn-out textiles (composed of natural fibres, from sources such as flax, hemp, cotton, silk, nettle, mechanically processed into a woven fabric) would be used as a raw material for paper-making.

The use of wood as a raw material for the production of paper has only become common practice in the last 150 years, a relatively new trend in the context of paper-making's over 2000 year old history, which should not only be questioned in face of environmental concerns, and also is reconsidered in an industrial context. The technology of paper-making is based on the hydrogen bridge bonds of cellulose fibres, a chemical process, which requires water as a medium. The quality of paper is determined by the fibre length of the raw material, among other factors.

In the workshop, various production methods were applied to investigate how different fibres might enable the creation of different products. Beginning with the classic preparation of textile fibres in the milling process of the Hollander beater, and followed by the formation of the sheet using a screen, using various methods, it is possible to create a varied range of paper types. Alongside the technological transformation of the fibres, the potential for design variations is demonstrated: various methods of fibre preparation and mixed blends result in visible and tangible variations, which not only create functional differences, can also have a significant impact on the perception (recycling/upcycling) of the raw materials used.

Additionally, it is possible to experiment with three-dimensional designs made from fibre pulp through the use of ready-made moulds.

Biodesign and Biomaterials

26. - 28.04., 09.05.2018
Dr. Flavia Barragan, Fara Peluso, Lisa Stohn
TopLab Berlin e.V.

Grow Your Own Materials Crash Course

Biodesign, or the use of microorganisms and biotechnology in design, emerges as one of the newest design practices being applied in the fields of architecture, food, materials, energy, communications, manufacturing, and many more. It provides an alternative approach to help tackle some of the environmental and economic problems associated with the textile and food industries.

This workshop served as an introduction to biodesign and biomaterials grown by microorganisms. The participants learned how to grow leather-like materials from bacteria or mycelium, how to use natural bacteria to create printed textiles, or cultivate algae for the extraction of sustainable pigments.

Module 1. Vegan Leather
Dr. Flavia Barragan

During the first session, participants learned how to prepare the fermented tea Kombucha in the format of a DIY cooking class. This resulted in "Scobys" - (Symbiotic Cultures of Bacteria and Yeast), which are thick jelly-like surfaces. The main emphasis was on the manipulation of the growth (intensity, direction) of the mycelium as well as influencing the materials' color and smell.

A few weeks later, the "Scoby" was ready to be harvested, dried and shaped.

Module 2. Bacterial Pigments
Dr. Flavia Barragan

Participants were introduced to different types of colour-producing bacteria and followed demonstrations on how to correctly work with such matter, including the health and safety considerations. Students created their own designs and patterns on LB-agar plates/LB-agar containers using the bacteria and various incubation conditions. Afterwards they printed the "grown" colour on their chosen material (e.g. fabric, paper, wood).

Module 3. Algature
Fara Peluso

Algature was a workshop about species of algae and diatoms, and how to grow and extract pigments from them. Diatoms are photosynthetic microalgae that produce 20% of the oxygen on Earth. They are the most important small organisms but are widely unknown. Although tiny, diatoms play an immense role in keeping the planet's ecosystem working. They are important mediators of carbon and oxygen cycles, an integral component of marine food webs and the principal cycles of silica, which constitutes 25% of the Earth's crust.

The workshop showed the general features of algae and diatoms (photosynthesis, aspects, colors etc.) and how they can be cultivated at home. One learned how to build a photo-reactor and discover the infinite and interesting possibilities of Speculative and Bio Design. The second part of the workshop was focused on the extraction of algae pigments, using a process normally adopted for all types of vegetable, obtaining pigments both in liquid and dry state.

Module 4. Grow and Manipulate Mycelium for Design Purposes
Lisa Stohn

The workshop served as an introduction to work with mycelium in the context of design with two main emphases:

1. Supporting weak structures: the mycelium can create dense meshes, and by growing in and around specific structures it can strengthen them from inside and outside as a connecting layer. In this way it is possible to create structures with new characteristics.

2. Connecting materials: the mycelium can be used as a connecting layer between two materials of the same or different composition. Its dense mesh can grow into the smallest interspaces of the material and create a strong bond.

3D-Printing Workshop by Babette Wiezorek, May 2018

Dyeing with Natural Dyes
24. - 25.05.2018
Anne Hederer
Dye Lab, weißensee kunsthochschule berlin

In the dyeing course, participants learned about the possibilities of dyeing with natural materials. Both dried and fresh plant material was used for dyeing, for example: madder, goldenrod, weld and walnut, and parts of different plants, such as flowers, roots, leaves, and bark.

After working together to learn about dye plants and the general techniques of dyeing, the practical part of the workshop began. The fabrics were prepared in mordant baths, the materials pre-soaked in water, and the dye baths were set up in order to dye varied natural fibre materials such as wool, silk, cotton or linen, by experimenting with various dyeing techniques. The students gained the opportunity to methodically test the effects of various plant-based pigments – hue, intensity and saturation, colour fastness – on different types of fabric qualities.

The processes carried out in the workshop were recorded systematically, and the results collated in an archive.

3D-Printing with Fluid Materials
02.05.2018 and 19. - 20.05.2018
Babette Wiezorek
Graduate of MA Product Design, weißensee kunsthochschule berlin

The workshop offered a basic introduction to the technology of 3D-Printing with fluid materials, such as ceramic pastes. How does this additive and computer-based process work? Which materials can be printed? Which properties and consistencies must the fluid materials possess in order to be printable? What can this technology offer in comparison with other production techniques? What are its limitations?

In the course of the workshop, the participants focused on various concepts of data generation and processing; they got to know the Delta printer, and the requirements of the printing paste.

The participants gained the opportunity to test how suitable their own material experiments and samples would be for 3D-printing, and how they might need to be adapted and developed further. Conversely, the participants were encouraged to question how the geometry of their designs might be adapted, in order to satisfy the requirements and characteristics of the material at hand.

Papermaking Workshop by Gangolf Ulbrecht, April 2018

Symposium Greenlab 7.0, April 2018

GreenDesign$^{7.0}$

symposium

Speaker Abstracts
and Biographies

Symposium - GreenDesign 7.0
Speaker Abstracts and Biographies

Symposium, April 2018

Interdisciplinary Approaches to Environmental Impact

Dr. Kat Austen, Cultural Fellow in Art and Science, Cultural Institute, University of Leeds, Leeds / Berlin

Dr. Austen discussed how interdisciplinary collaborations between designers, researchers and community can help shape new solutions for sustainable and resilient stewardship of resources. She introduced a prototype toolkit for co-design and discussed specifically the design, implementation, and realisation of an open source calculator that allows non-specialists to explore the carbon footprint and resource implications of design decisions.

Dr. Kat Austen's interactive artworks explore embodied routes into themes of environment, social justice and digital culture, exploring networks of unseen influence and truth-seeking actions through multimedia experiences and participatory means. She is Artist in the Arctic for Friends of SPRI, University of Cambridge, Bonhams and One Ocean Expeditions; Cultural Fellow in Art and Science at the University of Leeds; lectures at University College London's Bachelor's Arts and Sciences and is Artist in Residence in UCL's Faculty of Maths and Physical Sciences.

Biodesign – Rethinking the Way We Make Things

Dr. Flavia Barragan, Chemist & Bioscientist, topLab, Berlin

We are entering a new material age where products start to be grown instead of made. Biological systems and processes are changing the paradigm of design, offering the possibility to enhance functionality while improving environmental and economic impact. Through different case studies, 'Biodesign, rethinking the way we make things' explored innovative examples of design for sustainability using biotechnology and living organisms such a bacteria, algae, mushrooms and yeast.

Flavia Barragan, PhD in Chemistry from University of Barcelona and interdisciplinary researcher, explores the potentials of biomaterial and biological processes in design practices. She is a co-founder of topLab, a community biotech laboratory in Berlin for art, science and technology, where she carries out her independent research. Since 2017, she has collaborated with the greenlab at weißensee kunsthochschule berlin, teaching biotech to design students. She has co-curated DEMO 2017, a festival that explores new creative processes in design.

A New Relationship Between Designers and Materials for More Circular Design

Prof. Aart van Bezooijen, Burg Giebichenstein, University of Art and Design Halle Founder of Material Stories, Hamburg

Moving towards a circular economy requires a different way of dealing with the valuable resources of our planet. A circular economy does not only involve economics but demands a stronger integration of social and ecological aspects of the way we design and make things. With a closer look at the (new) relationship between designers and materials we discover great opportunities for the designers of the future dealing with digital manufacturing, urban mining, open source methods and material farming. The talk was aimed to inspire designers who are ready to explore, question and respect the wonderful resources our planet has to offer.

Aart van Bezooijen is a Dutch industrial designer with an obsession for materials. In 2005, he founded the agency Material Stories, which supports companies, organisations, designers, and educators with material consulting, material research, innovation workshops, lectures and trend reports. Since 2012, he is also Professor for Material and Technology Transfer at the Burg Giebichenstein University of Art and Design Halle, establishing the university's material collection with the platform MAKE.

Fashion at the Crossroads – Successes and Future Challenges of Greenpeace's Detox Campaign

Dr. Kirsten Brodde, Greenpeace Germany

Greenpeace's Detox campaign has been challenging the textile industry to take responsibility for pollution occurring throughout supply chains. It has set high standards through a combination of rigorous targets and full transparency on tracing inputs and releases of hazardous chemicals. The industry's response is the big promise to aim for circularity to maintain the destructive growth trajectory and to avoid slowing down the overproduction and overconsumption of clothing. In 2017 Greenpeace published "Fashion at the Crossroads" which sets out a holistic framework to address the whole life-cycle of clothing and to maintain a critical focus about the big claims being made for circularity by global brands.

Kirsten Brodde leads Greenpeace's global "Detox my fashion" campaign that secured 80 global commitments since 2011 from well-known brands, retailers and suppliers to ban hazardous chemicals from their supply chains. Prior to joining Greenpeace, Brodde worked as a science journalist and author. In 2018 her new consumer guide about eco fashion will be published. Brodde studied medicine, German literature and linguistics, receiving her PhD in journalism from Hamburg University.

Genetic Architectures and Biological Urban Lighting

Prof. Dr. Alberto T. Estévez, Director, Institute For Biodigital Architecture & Genetics, ESARQ School of Architecture, Universitat Internacional de Catalunya, Barcelona

The presentation included a brief history about the beginning of the practical application of real genetics to architecture and design. Considering genetics introduces a privileged point of view on biology and the digital realm, and these two are the main protagonists in our "posthuman" society. Genetics are becoming the cornerstone of our posthuman future precisely because they are at the crossing point between both fields, Nature and Computation, and because they are a science that can command both of them from "within". Meanwhile, through genetics and biodigital architecture and design, we are searching for the knowledge frontier for planetary benefit.

Alberto T. Estévez, Architect (UPC, 1983), Architecture Ph.D. of Sciences (UPC, 1990), Art Historian (UB, 1994), Art History Ph.D. of Arts (UB, 2008). Founder and Director of ESARQ (UIC Barcelona, 1996), where he now teaches. He also founded the Biodigital Architecture Master and the Genetic Architectures Research Group & Office. He has produced more than 100 publications and participated in a large number of exhibitions and conferences around the world.

Natural Fibre-reinforced Bioplastics – A Step Towards Sustainable Construction Materials

Dr. Holger Fischer, Faser- und Materialentwicklung, Faserinstitut Bremen e.V.

Natural fibres are a hidden champion in the composites market. They make up approx. 25% of the long-fibre reinforced plastics with their main market in the automotive sector: 90,000 tons of fibres in 150,000 tons of composites in the German automotive industry. The presentation highlighted technical and economical reasons for the use of natural fibres. Based on the results of recent research, there was a brief overview on future perspectives of natural fibre-reinforced biopolymers as a totally bio-based and more sustainable alternative. Aspects of competition to food production, circular economy and recyclability were discussed.

Dr. Holger Fischer is a chemist, who studied at the University of Bremen (PhD: 1994). Since 1997 he has worked as a Senior Researcher at the Faserinstitut Bremen e.V.- FIBRE, in the area of natural fibers and biopolymers. His research topics include enzymatical fibre modification, fibre characterisation, natural fibres, natural fibre-reinforced plastics and biocomposites. He is a member of several scientific boards and of the European Technology Platform for the Future of Textiles and Clothing (ETP).

Living Colors – Redefining Color Through Materials Research

Essi Johanna Glomb, Designer & Researcher, Studio Blond & Bieber, weißensee kunsthochschule berlin

"Color is not a trend" – every material and resource carries its individual inherent color. Studio Blond & Bieber uses unexpected materials as an essential part of their design strategy – each of those materials offers an entirely new color palette. Working with "living colors" can be seen as an obstacle, yet at the same time it opens up new forms of storytelling. The studio's initial project "Algaemy" explored the potential of microalgae as a natural pigment for textile printing and started a profound research on how working with new and sustainable materials can redefine our perception and use of color in the future.

Studio Blond & Bieber was founded by textile designer **Essi Johanna Glomb** and product designer **Rasa Weber** in 2013. The studio is an experimental space for projects at the intersection of interdisciplinary design and scientific research. Applying innovations from science and traditional crafts to new design approaches, Studio Blond & Bieber creates a narrative of "future crafts" based on collaborative work from various fields that are combined in a material lab with sustainable product design solutions. Their work includes collaborations with numerous research facilities which have won international awards and been featured in the media.

relab – an Experimental Case Study to Create a Circular Material Flow at the weißensee kunsthochschule berlin

Lilith Habisreutinger, Product Design student, weißensee kunsthochschule berlin

The 'relab'-project is an experimental case study that seeks to bring the global issue of our wastefulness to a tangible scale. By viewing the material flow at the weißensee kunsthochschule berlin as a micro-representation of the global materials economy, the project aims to find creative ways to disrupt the conventional linear economy and convert it into a more circular system. The approach can be described as a series of experimental interventions that reach from building up an infrastructure for material exchange, to furthering participation through events and visualizing the urgency of addressing this issue within design education.

Born 1990 in Munich, **Lilith Habisreutinger** is currently a student of product design. During her studies in the Netherlands and Germany, her main focus has always been on designing objects in a sustainable way. Not long ago she has broadened this approach to include aspects of post-use scenarios. Her graduation project 'relab' is the most recent display of this evolution.

Ecological Interactions and Modes of Industry

Jonathan Minchin, Project Manager IAAC/Valldaura Labs, Barcelona/London

Throughout the course of development, the human means of resource procurement, production, distribution, and consumption have changed dramatically and systemically — evolving through scales, geographies, circumstance, society, and technology in profoundly impactful ways. ‚Ecological Interactions and Modes of Industry' submitted concepts and presented tools for analysing and understanding these changes. Descriptions of varied case studies from current and emergent industries outlined a discourse and offered indicators of future systemic change, and asked 'What modes of industry might provide for human needs whilst operating within the carrying capacity of planetary systems?

Jonathan Minchin has an MSC in 'International Cooperation, Sustainable Emergency Architecture' (2010) and has worked with development projects alongside Habitat for Humanity in Costa Rica, UNESCO in Cuba, Basic Initiative in Tunisia and with UN Habitat in Barcelona. He began the Green Fab Lab at IAAC Valldaura Labs campus in Barcelona 2013, engaging the 'Fab Academy' and 'Bio Academy' programs. His ongoing projects include Open Source Beehives (OSBH), Robotics for Micro Farms (ROMI), the Zero Series circular economy workshops and OpenLab.org.

Cradle to Cradle in Practice

Ulrike Niesmann, Senior Project Manager, EPEA Internationale Umweltforschung

Cradle to Cradle® stands for innovation, quality and good design. It describes the safe and potentially infinite circulation of materials and nutrients in cycles. This requires intelligent concepts, good design and careful selection of materials. Combined with a clean production and a clever return of the products to the "nutrient cycle", products are created that are holistically "beautiful". Ulrike Niesmann presented the concept behind Cradle to Cradle®, introduced important tools for product development and showed successful examples of Cradle to Cradle products.

Ulrike Niesmann is working as a project manager at EPEA Internationale Umweltforschung GmbH. Her core business is the implementation of the Cradle to Cradle concept into the DNA of different companies. She is working with all departments within the cooperating companies – from product development to purchasing and marketing.

Ulrike Niesmann studied Industrial Design at the Muthesius Kunsthochschule Kiel and at the Design Academy Eindhoven and Environmental Science at the University Lüneburg.

Shaping Futures – Material Flows and Human Economies
Prof. Dr. Lucy Norris, weißensee kunsthochschule berlin

As human beings we are embedded in our material environment, and we become who we are as people through processes of making and exchange. Designing for the circular economy requires us to develop new materials, new technologies, and new systems to keep those materials in circulation. The challenge in these future-making practices is to envision circular economies that foster the values of an open society through the transparent and equitable use of resources, and build confidence in our ability to shape the moral politics of materials and markets.

Lucy Norris is Guest Professor of Design Research & Material Culture at weißensee kunsthochschule berlin. She is a social anthropologist researching cultural perceptions of materials, the politics of value, and theories of waste, exchange and circulation. She obtained her PhD at University College London, and has carried out long-term fieldwork in India and the UK on second-hand clothing economies, industrialised handloom cloth production and textile recycling industries. Details of her publications, curated exhibitions and collaborations with visual artists can be found at www.lucynorris.co.uk

Biomimicry: What Nature Can Teach us About Circularity, Value and Innovation
Dr. Arndt Pechstein, phi360 innovation Hasso-Plattner Institute, Berlin

With entire industries witnessing disruptive changes and anthropogenic changes happening world-wide, a new mindset and the implementation of new approaches are imperative. Sustainable, systemic solutions gain increasing importance and it seems natural that the design of our products should draw inspiration from the biological world. Consequently, Biomimicry, the discipline that abstracts biological design principles to human problem solving, has experienced significant growth over the past years. Dr. Arndt Pechstein, Biomimicry specialist and expert in human-centered innovation is pioneering this innovation method in Germany and introduced novel approaches of problem-solving and bio-inspiration. By forging a positive instead of an adversarial relationship between technology, business, and the environment, Biomimicry promises to be a societal and economic game changer.

As an multi-award winning entrepreneur, coach, and specialist in Neuroscience, Biomimicry (bio-inspired innovation), Design Thinking (user-centered innovation) and Digital Business Models, Berlin-based **Dr. Arndt Pechstein** advises organizations in adaptive leadership, resilient and learning networks, disruptive innovation, and digital transformation. Arndt is founder of the innovation firm phi360.eu, and founder and director of the German Biomimicry think-tank. He serves as advisor for automotive, banking, pharmaceutical, energy, manufacturing, e-commerce, and education.

Designing Material Ecosystems
Anastasia Pistofidou, Founder FabTextiles and Textile Academy, Barcelona

Technological advances, new materials and computational design are changing the way we design and manufacture products, consume and interact. At fabtextiles and materials lab at Fab Lab Barcelona we are developing and implementing a new approach to creating, producing and distributing fashion elements by using distributed manufacturing infrastructures and knowledge networks. We are experimenting with scanning the human body, creating interactive wearable garments, working with biomaterials and circular processes, using 3D printing and parametric 3D modelling. Within this context our practices prescribe the role and profile of future designers. What are the new skills, materials and processes for the future generations?

Anastasia Pistofidou is a Greek architect specializing in digital fabrication technologies, design and education. She has a Master's degree in Digital tectonics from the Institute for Advanced Architecture of Catalonia (2010-2011) and a Bachelor's Degree from the Aristotle University of Thessaloniki, department of Architecture (2008). She currently works as the director of the FabTextiles research lab and the "Fabricademy, a new Textile and Technology Academy". She combines the analogue and the digital towards applied research focused on new materials, art and textiles.

Engineering Circularity – Circular Economy by Design
Björn Schlingmann, Engineering Lead, Miniwiz Europe GmbH & Johann Bödecker, CEO Pentatonic GmbH

Miniwiz, an international Architecture and Engineering company, has been in the upcycling business for 12 years. Pentatonic was founded 2017 as the first circular homeware brand. How do these two companies approach design for circularity and which steps can you as a designer take to do the same?

Born in Berlin, **Johann Bödecker** spent over seven years working for Miniwiz Co. Ltd. Taipei, the pioneering execution-oriented closed-loop firm behind projects such as Ecoark. As a partner he managed Miniwiz' western B2B clients and partners such as Nike, Coca-Cola, and Starwood hotels and resorts, developing custom solutions for their waste problems and creating circular material flows within their eco-systems. Johann founded Pentatonic with co-investment from Miniwiz in order to bring loop-economy innovation directly to the consumer, starting in Europe.

Björn Schlingmann (Co Speaker) studied Mechanical Engineering and Industrial Design at the University of Applied Sciences in Emden, Germany. After one year of work in the bicycle industry he attended the Master's programme "Product Development" at Chalmers University of Technology in Gothenburg, Sweden. He joined Miniwiz in 2014 and worked in the Taiwan office for three years on a variety of projects. When the Berlin office opened in 2016, he relocated back to Germany as the lead engineer for Miniwiz Europe.

DRYVER – A mobile Cloud Service
Annette Schmid, Designer
Ronnenberg Creative Technology, Hamburg / London

DRYVER is a social and philanthropic robot that uses condensation techniques to produce water from air. It drives through the city and provides freshly generated water to passers-by on the streets. People can interact with the mobile drinking fountain via speech recognition, and in exchange for the water, they are asked to charge the batteries by operating the side-crank – so the DRYVER can continue to move and serve others. Water has gone from a free natural resource to one of the most successful commercial products of the last hundred years. DRYVER offers the ultimate-local proposal for freely available drinking water, reflecting the absurdity of filling water into bottles and driving it across countries.

Annette Schmid is designer at Ronnenberg Creative Technology. The studio works at the interface of reality and fiction exploring our relationship to past, present and future technologies through design. Dividing their time between Hamburg and London, the studio creates philanthropic future versions by designing innovative prototyping concepts, interactive systems, technologies, tools, and products.

Innovation Management and Circularity at BSR
Frieder Söling, BSR, Vorstandsbüro Energie, Umwelt, Innovationen, BSR, Berliner Stadtreinigung

The Berlin City Cleaning Services (BSR) is using its ideas laboratory to take an unusual approach to changing the culture of innovation in the company and to launching innovative projects. Frieder Söling, member of the ideas lab introduced the BSR innovation management and reports on the company's activities in the area of circular economy. In recent years, the topics of waste prevention and reuse have been the focus of attention. For example, the ideas lab 2017 initiated a walk-in pavilion made of discarded materials at the International Garden Exhibition.

Frieder Söling has been working as an innovation manager at the Berlin City Cleaning Services (BSR) for almost ten years. During this time, he helped build BSR's award-winning ideas laboratory. The activities of Mr. Söling include measures that can be implemented in the short term, such as the testing of cargo pedelecs for city cleaning and future topics such as the use of robotics in waste management logistics.

Waste is a Design Flaw. Investigating the Role of Design in the Circular Economy
Sophie Thomas, Thomas Matthews; Founder of The Great Recovery Project, RSA, London

What happens when our waste streams become too dirty and contaminated for businesses and countries to accept for re-use and recycling? The current public outcry over plastic pollution in the oceans is evidence that our neglect in optimising the end-of-life recovery of materials – both in the way we design the product to be completely recyclable and in the system that currently allows so much leakage into the environment – is not acceptable any more. The circular economy offers a way forward towards more efficient and closed loop systems and it all starts in design.

Sophie Thomas is an established leader in communication and design and in the investigation and promotion of circular economy design principles. She has been working in ethical design, behaviour change, and material process through her agency, Thomas Matthews for 20 years. In 2012, she also founded The Great Recovery, to investigate the role of design in a circular economy. Using the insight taken from end-of-life processes she has built an in-depth knowledge of material use and is now a chartered waste manager.

Open Source & Circularity – Why is it the Perfect Match and How to Make it Work
Lars Zimmermann, Artist & Economist, OSCE Days, Berlin

The talk explained why Circularity needs Openness if we really want to make it work in a global complex economy and how to create design objects and products with an Open Source Circularity tool- and mindset.

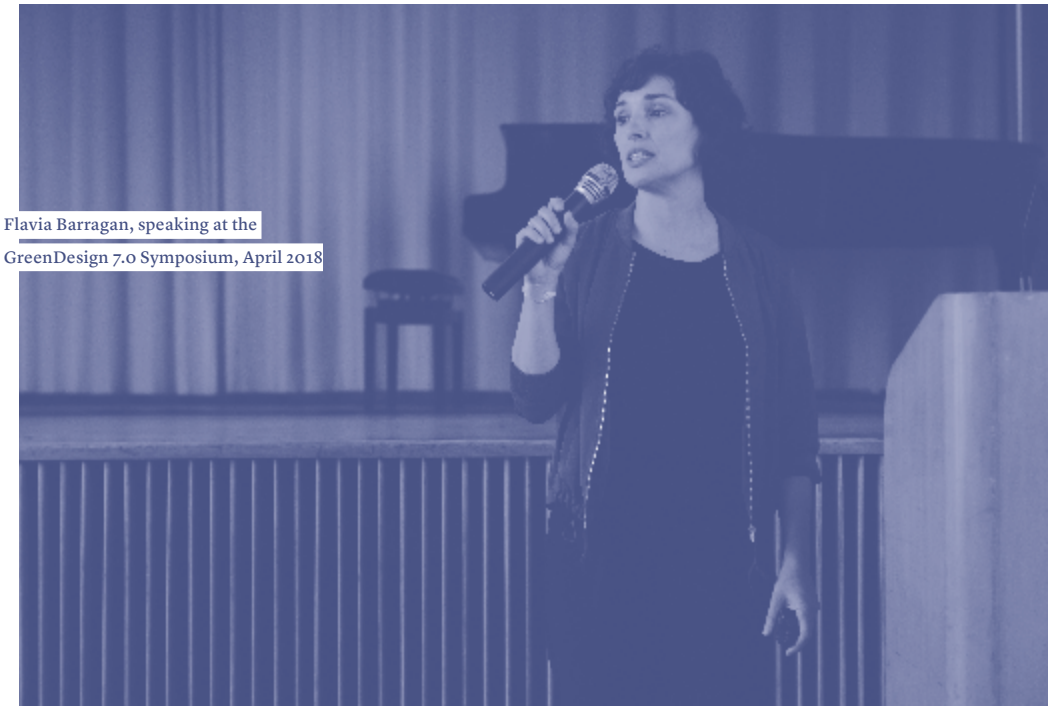
Lars Zimmermann (larszimmermann.de) is an artist and economist based in Berlin. He has been exploring openness in connection to circularity for several years now in projects like The Open Source Circular Economy Days (oscedays.org), Mifactori (mifactori.de) and The City Is Open Source (thecityisopensource.de) and others.

Biodesign and Biomaterials Workshop by Dr. Flavia Barragan, Fara Peluso, Lisa Stohn, April 2018

GreenDesign 7.0

dr. flavia barragan

Interview



Flavia Barragan, speaking at the GreenDesign 7.0 Symposium, April 2018

Interview with Chemist and Bioscientist Dr. Flavia Barragan

greenlab Why did you study biology and chemistry?

Dr. Flavia Barragan In my case it was a practical decision rather than vocational. When I was in high school I was drawn to science and I really enjoyed chemistry, however I didn't have a clear idea about what I wanted to do afterwards. Coming from a small town with limited possibilities for higher education, the choices in the science field were either chemistry or engineering. I chose chemistry. My interest for biology came much later, once I started to work as a researcher.

GL What is your professional ambition as a bioscientist?

FB First of all I would like to raise awareness about the potential that cross-collaborations have in the different areas of knowledge, and encourage scientists and other professionals to try and work with it. This awareness is crucial for building communities, collaborating together in a lab and implementing ideas. I hope that with a diversity of views, we scientists will contribute to develop a more critical thinking towards the way socioeconomic systems work.

GL Which health and safety precautions must be taken when working with living organisms such as bacteria, cells, etc?

FB The EU sets standards for the safe handling of microorganisms according to their Biosafety Level (BSL). There are four biosafety levels. BSL-1 corresponds to the lowest risk microorganisms and BSL-4 to the highest. The type of organisms we can work with in teaching spaces are usually BSL1, which are categorized as non-pathogenic in healthy humans and present little risk to the environment. Still, there might be potential risks (infections, for instance) for people with compromised immune systems, therefore it is important to follow appropriate guidelines. There are organizations, like DiyBio, that give free access to protocols and guidelines for the correct manipulation of these microorganisms. Most of the risks are easily manageable: we just need to follow the protocols, wear personal protective equipment (lab coats, gloves, safety glasses), wash our hands when exiting the lab, and just as important, sterilize biological waste before disposal.

GL How did you come into contact with design as a scientist and what interests you personally about this connection?

FB I am lucky that many inspiring things in my life have been introduced to me by friends. Back in 2013, when I was doing my post-doctoral fellowship at Brooklyn College of CUNY, my friend Cristina Noguer was studying her Masters in Interior Design at Parsons. Experimenting with alternative materials was one of her favorite topics, and we used to spend a lot of time discussing her projects and talking about biodesign. Through her, I discovered the potential of science in other areas of knowledge and realized that in combination with design practices it could help to translate scientific knowledge into innovative solutions that might change the way we produce things. That was incredibly inspiring. It transformed the way I saw science and sparked my curiosity for new possibilities in science. Then one day, my friend Merche Blasco, a sound artist and engineer, told me about a coworking space in Brooklyn, where among architectural, design and art studios, there happened to be a laboratory for synthetic biology. I later discovered it was Genspace, a community biotech lab where anyone could learn about biotechnology, at any level. I was immediately fascinated with the idea of learning science outside the conventional setups, and took a class in biodesign.

GL Where do you see the potential in collaborations between science and design?

FB In my opinion, science and design complete, inspire and reinforce each other. Collaboration between them is key to translating advances in biotechnology into better processes and products for our daily lives and ecosystems. The collaboration is bidirectional and benefits both sides. On one hand, scientists can benefit from the ability of designers to communicate concepts in a simpler way, and the experience of designers in product design and manufacturing can help scientists to overcome challenges early on. On the other hand, designers can take advantage of early-stage scientific developments to improve the functionality or to reduce the environmental impact of their products.

GL How would you compare the methodologies used in science and design?

FB My experience in design is relatively recent, but I think both use creativity and a lot of trial and error during their process. My feeling is that designers and artists really understand the importance of communicating their ideas, so their practice is very much oriented on visualization. Scientists, however, are more focused on publishing research in scientific

journals, which many times are too technical and difficult to understand for people without a specific scientific background.

GL What are the differences in the way in which science and design students identify and approach a problem or issue?

FB It is difficult for me to identify particular differences between the way designers and scientist approach their work, since both fields are very broad and can materialize in may forms. In my experience, design students often address problems from a global industry perspective connecting several sides of the same issue (for example, using waste to produce recycled materials), while chemistry students focus more on one specific aspect, investing a lot of effort to improve or modify one particular feature (for example, making that material waterproof).

GL What do you understand by biodesign?

FB For me, biodesign is the use of biotechnology and living organisms like microbes, bacteria, fungi, and algae in any design practice from textile and products to construction and architecture.

GL What was your experience of teaching biotechnologies to design students at weißensee kunsthochschule berlin?

FB I am very pleased to have had a chance to work with weißensee kunsthochschule berlin students for two consecutive years. I always enjoy my time with them, not only as a teacher, but also hearing about their projects and ideas. Teaching at weißensee kunsthochschule berlin has always been inspiring and enriching. Students were avid to know new things, to experiment, to learn. One of the aspects I enjoyed the most, was seeing them becoming more familiar and confident with the topic and developing great science-oriented projects without having a scientific background.

My course is usually built up in 2-3 sessions, where at the start students were introduced to the basic biotechniques and had their first contact with some microorganisms. Afterwards, some of the students would go a bit further and develop their own projects. At that stage they would gain a better understanding of the process. It was fascinating to see the students run their first experiments. In many cases they had to use all their imagination, design skills and organisatorial talents to build the infrastructure they needed externally, since weißensee kunsthochschule berlin does

not have a laboratory space. It was amazing to see how design and science worked together from the very beginning, and how much the students learned by facing different problems.

GL In your opinion, how could science-design collaborations be made more effective?

FB The first step would be to decentralize science from conventional institutions and research centers to lower the barrier between biotechnologies and other disciplines like product and fashion design, architecture, digital fabrication or construction. That would help to mitigate the stereotypes and clichés that both scientist and designers have about each other. Having semi-professional or DIY biolabs at art and design schools would facilitate an early interaction and understanding of the potentials of biotechnologies. Students would have the opportunity to explore alternative materials and production processes while gaining a hands-on experience in biotech. Through seminars, exhibitions and conferences, students and professionals of different areas could exchange knowledge and create a proof-of concept for further investigations. These actions could help establish future collaborations with companies, start-ups or technological centers and link often disconnectedsides of science, design and business.

GL After the preeminence of the "hard sciences" such as physics and mechanical engineering during the Industrial Revolution, subsequent socio-technological development ushered in the Digital Age. Significantly, this made the decoding of the human genome possible, at the start of the 21st century. It has been suggested that "hard sciences" are now giving the way to "soft sciences" such as bioengineering, and that we are now entering a Fourth Industrial Revolution that fuses the physical, digital and biological worlds. What is your opinion as to the role of biotechnology and biodesign in shaping the future?

FB I think that observation is totally correct. Advances in biology and biotech have caught the attention of a wide range of new disciplines, including fashion, food and architecture... While the industrial use of living organisms is not new (think about fermentation in food industry), the application of biotech and synthetic biology to design production methods is quite recent. Today, we can find biodegradable silk fiber developed using synthetic biology from a spider protein, animal-free leather produced from engineered mushrooms, or self-healing concrete that incorporates a particular type of bacteria capable of self-repair

cracks. For many, biodesign is a tool to remediate polluting and to rethink manufacturing and industrial processes. The question for me is whether we can achieve such transformations without supporting a new technological revolution that creates new needs, new environmental and economic issues. Making things with biology could be another way to make things; but maybe the question is, do we need more things? Biodesign is a powerful tool that could help us create a better future, but for that we should be critical to our economic system, think more from circular stand point and less from linear. This is where biodesign can show its greatest potential.

GL What opportunities do you think biodesign and bioproduction open up with regard to sustainability? For example, how are biotechnologies useful for improving our current wasteful use of resources?

FB In my opinion, one of the greatest potentials of biodesign and biotech is closely connected to the development of biodegradable materials and biofuels using local agricultural or industrial waste. In this way, the side-products of one industry become the nutrients for the next, creating circular strategies that minimize resources (water, energy), waste production, and environmental impact. See for instance biofuel production from algae cultivation using industrial waste water, or biodegradable alternatives to plastic from mycelium materials produced using mushrooms and local agricultural waste. Developing biodegradable products can reduce some of the common problems associated with recycling, which in many cases fails due to inability of cities and states to make the process profitable. Transforming waste into raw materials can create value for businesses.

GL To some extent, certain elements of bioproduction may need more time and are less easily reproducible in comparison to industrial (design) processes - are there advantages to this?

FB If by bioprocess we mean traditional production methods that use low-tech or non-tech at all, then I would agree about time requirements and poor reproducibility. However, bio-production using biotechnology and living organisms can be optimized to improve functionally, performance, and reproducibility.

GL Advances in biotechnology are drastically altering our cultural understandings of 'natural' and 'man-made'. They have the potential to completely change our

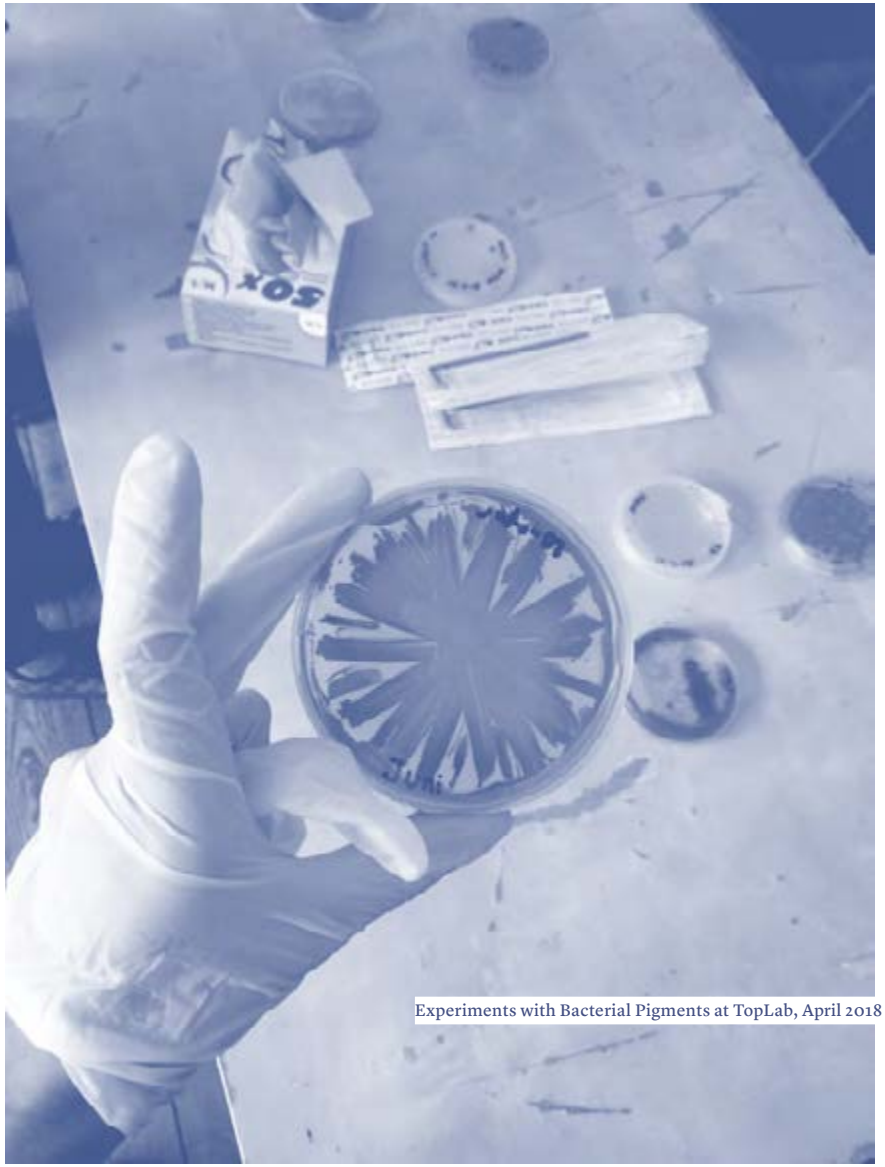
concept of the human being itself by altering the very essence of life. What is your opinion on this?

FB Seeing how quickly we have introduced technology into our lives and how rapidly human fascination to control our bodies and environments is growing, I do feel that this is the direction we are taking. As digitalization has reshaped industries, synthetic biology is on its way to do so too. Think for example about CRISPR, a fast and easy technology that allows us to edit the genome, making it easier to engineer organisms. Together with all of the advantages it offers, the production of new organisms might have an impact on biodiversity and even create new ways of life. But it might also open a possibility for new biological futures, where humans and microorganisms establish symbiotic relationships for a common benefit. Whether we are ready for it or not, there are other things with a bigger impact on us in a shorter future, like climate change which already affects our lives and might, if not will, change the world quicker and more dramatically.

GL In Goethe's famous story 'The Sorcerer's Apprentice' ("Der Zauberlehrling") a young boy casts a spell over his tools, a powerful enchantment which he lacks the power to control. If we make biological processes more accessible to people through FabLabs and open source platforms, how can we find new ways of exercising appropriate control?

FB Despite what some people might think, the risks of an amateur scientist developing a bio-weapon are quite low. In Europe, the Federal Office for Consumer Protection and Food Safety of Germany prohibited the use of synthetic biology and genetic engineering outside specialized facilities. The DIYbio and citizen science communities have a great sense of responsibility and transparency regarding continuous communication with the European Commission. Frequently, delegates from regional DIYbio groups from around the world organize meetings to discuss common practices and codes of conduct.

In fact, the EU has developed programs like SwafS (Science with and for Society) to foster collaboration between scientists, citizens and businesses in order to better align research with the needs of society.



Experiments with Bacterial Pigments at TopLab, April 2018

The TED‘s TEN
Sustainable Design Strategies

Since 1996, TED - the Textiles Environment Design research group, now known as CCD - Centre for Circular Design based at the University of Arts London, has been developing and refining a set of sustainable design strategies for textile and fashion designers. These strategies have emerged out of a need for a toolbox for designers to help them navigate the complexity of sustainability issues and to offer real ways for designing 'better'. While the environmental impacts of our production and consumption system have become increasingly discussed and brought to the fore, and textile/fashion designers have begun to consider their responsibilities as creators of unsustainable products and systems, there have been few tools or frameworks for designers to be pro-active. Frustrated by the lack of real action in light of these often depressing facts, TED wanted to create some strategies for positive change. These have now become The TEN, and are continually changing and adapting.

The TED‘s TEN Sustainable Design Strategies

1 – Design to Minimise Waste

This strategy encourages designers to minimise the waste that is created in the textile industry, both pre and post consumer. It includes zero waste cutting and recycling, but it also introduces the idea at the outset, that we need to avoid producing stuff, that does not work, that people dont want.

2 - Design for Cyclability

This strategy explains how when you design for cyclability, the thought process is very different, but totally connected to, the practice of recycling textiles.

3 – Design to Reduce Chemical Impacts

This strategy is about appropriate material selection and processes for any product to minimise environmental impacts.

4 – Design to Reduce Energy and Water Use

Energy consumption and water usage in the textile industry are extremely high and occur at each stage of the lifecycle of textiles – at the production stage, in the use phase (where consumers use and care for textiles and garments), and at the end stage (which covers either disposal and/or re use of the material.

5 – Design that Explores Clean / Better Technologies

Replacing systems of production with less energy consuming and smarter technologies to reduce environmental impacts.

6 – Design that Looks at Models from Nature & History

This strategy is about how much textile designers can find inspiration and information for future sustainable design from studying and reflecting upon nature as well as textiles, habits and societies of the past.

7 – Design for Ethical Production

This is about design that utilises and invests in traditional craft skills in the UK and abroad. It is about ethical production which supports and values workers rights, and the sourcing of fair trade materials. It questions what ethical production means, and how it differs for each scale of production and manufacture.

8 – Design to Reduce the Need to Consume

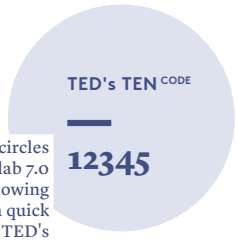
This strategy is about making stuff that lasts, stuff that we really want, and want to keep and look after, and the design and production of textiles and products which adapt and change with age. This strategy is also about exploring alternative forms of design and consumption such as co-design and collaborative consumption.

9 – Design to Dematerialise and Develop Systems & Services

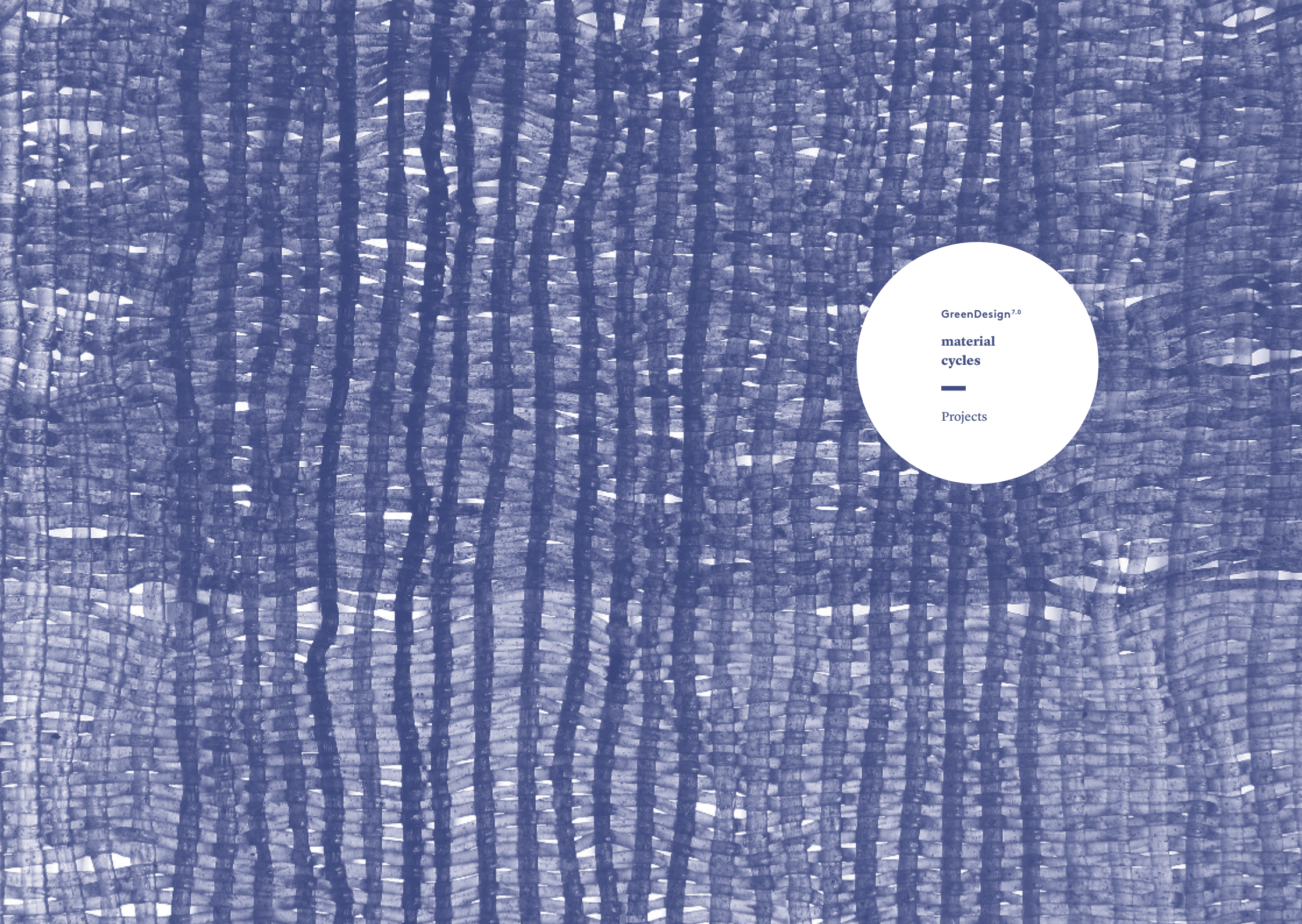
This strategy introduces the concept of designing systems and services instead of, or to support, products, e.g. lease, share, repair.

10 – Design Activism

In this final strategy we encourage designers to leave behind the product and work creatively with the consumers and society at large. It is about designing events and communication strategies beyond product design to increase consumer and designer knowledge about the environmental and social impacts of fashion and textiles. Here, the textile designer becomes a ‘Social Innovator’. We reflect on how much has changed for textile designers, and how much potential for the future there is!



Please watch out for these circles when reading about the greenlab 7.0 student projects on the following pages! These will give you a quick reference about which of the TED's TEN strategies the students focused on within the framework of their individual projects.



GreenDesign 7.0

material cycles

Projects

Irina Hefner

Kombucha

The surface extends over the water. It accepts almost any format. The water becomes murkier and begins to come alive. The yellowish cloud turns into gelatinous layers. It rests and becomes juicier and denser. The skin marbles, changes colour, and touch – depending on what is added to it. You wait, watch and feed it. Until the time comes to take it out. Put it down carefully and drain it from water. Now it is transparent: Not paper and not leather. It is flexible, but it tears easily.

Its gracefulness is irritating. It is beautiful, yet repelling, fetish and nature at the same time. It reminds of ages long gone. But can it meet today's needs?
The attempt of a collection. It will be jacket, trousers or shirt. But in its pureness it is vulnerable. Moisture returns it to its origin, leads to dissolution. Moisture is body - body is fashion. Is this vulnerable material worth the effort of growth, the feeding, the time? Should we still call it sustainable design?

TED's TEN CODE

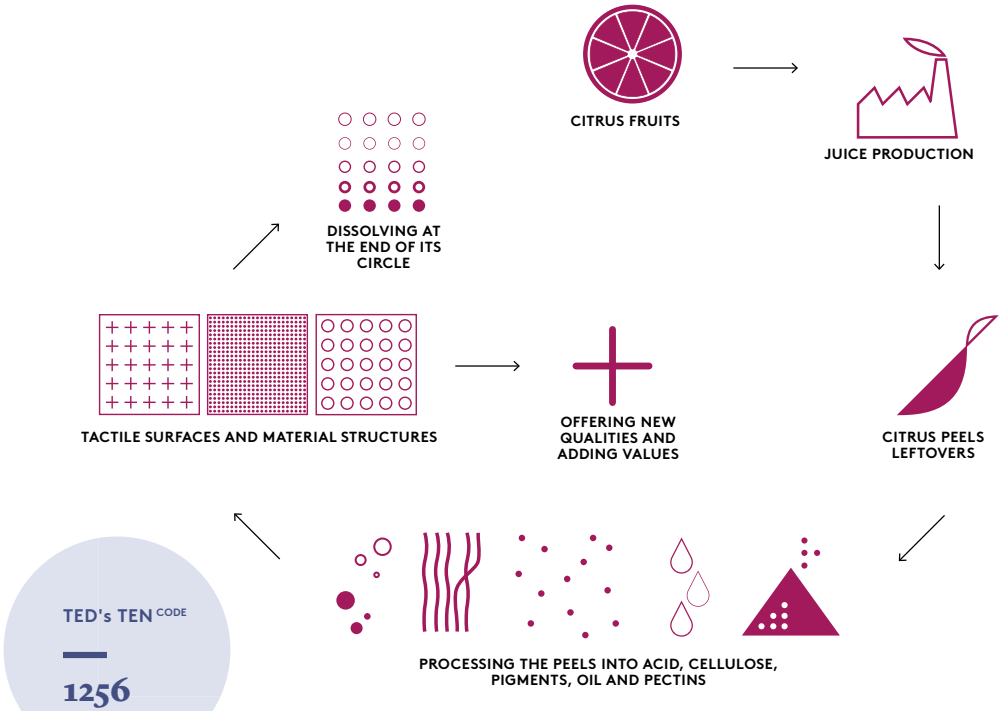
1256

How can a composite material made from regional biological waste be applied to packaging?

Ralph Zähringer

Overall, bio-plastics have great potential to replace conventional plastics, whereby their qualities lie, above all, in their sustainability and biodegradability, but also in their often special, nature-like haptics. In the case of bioplastics made from citrus fruit peels, different pectins and other biopolymers ensure that films feel comparatively velvety.

new tactility The bioplastic films developed in the project consciously reinforce these properties and impressions through special embossings or perforations of the sheet materials. These surfaces create a subtle sensitivity for the material and its handling, thereby transferring their special value to the product, for example when used as packaging material.



TED's TEN CODE

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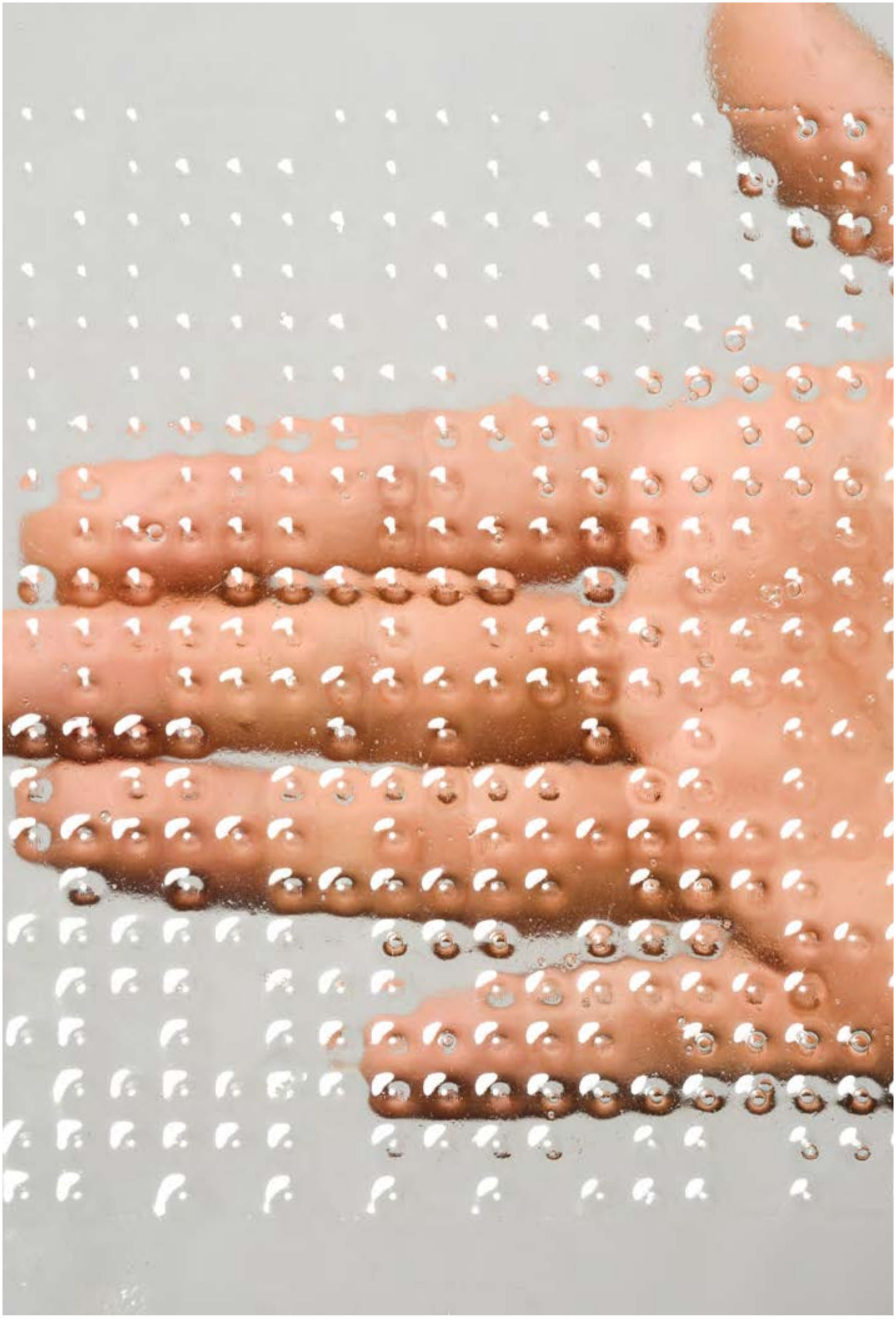
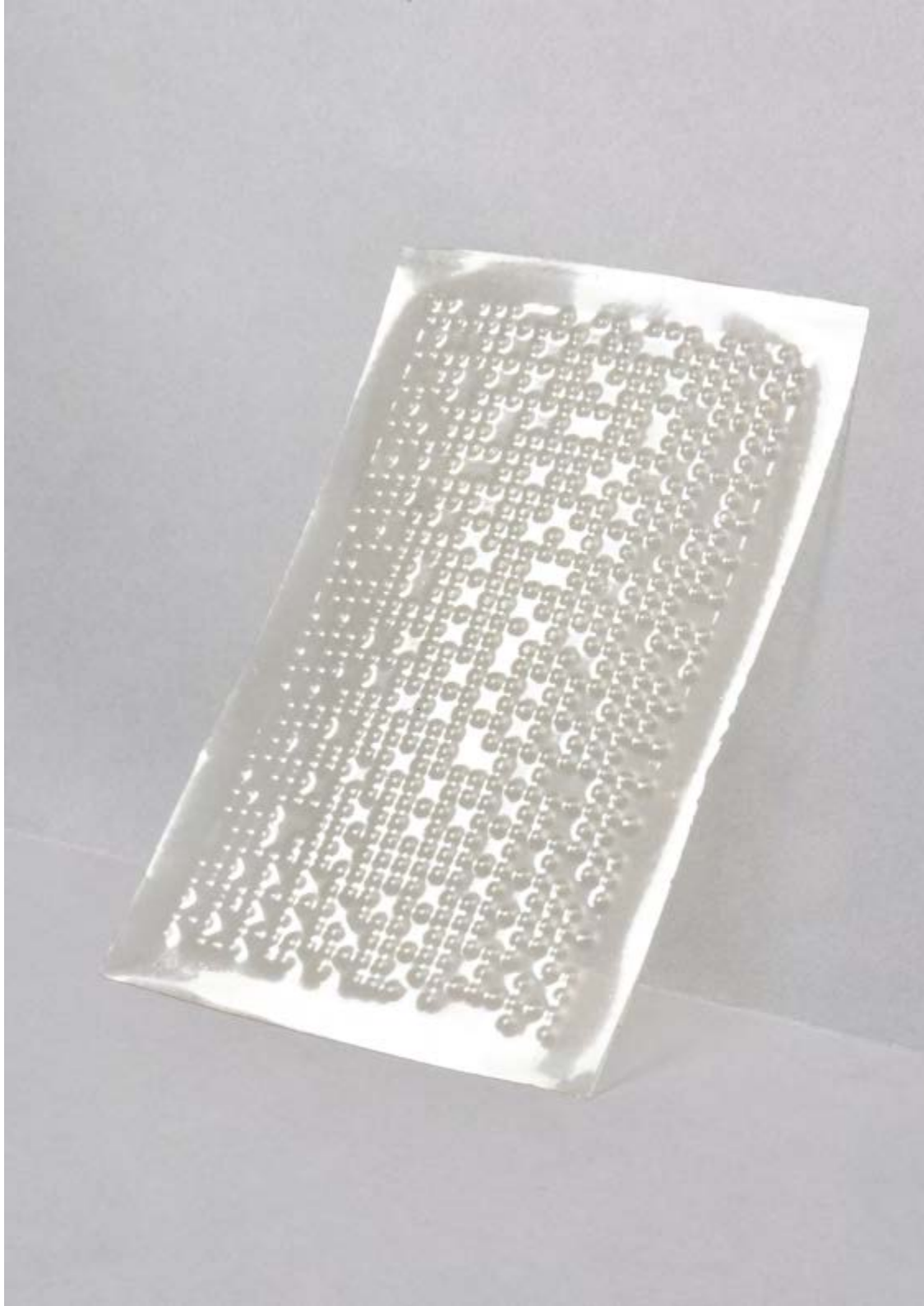




Which rituals and products enable us to use cosmetics in a more sustainable, healthy manner?

TED's TEN CODE

138

Carolina Sprick

In contrast to 'Clean Eating', 'Clean Cosmetics' are not yet a recipe for commercial success. Empty promises and dubious ingredients form a shady alliance, one which continues to support a modern cosmetics industry suffocating in packaging waste. Microplastics, tensides and parabens not only irritate the conscious consumer's skin, but also test their patience. **translucent** Translucent is a long-lasting DIY kit, which enables users to create their own organic cosmetics, offering customers a clear and transparent alternative to the product jungle of cosmetic beauty care: A system based exclusively on natural raw materials from your own pantry.

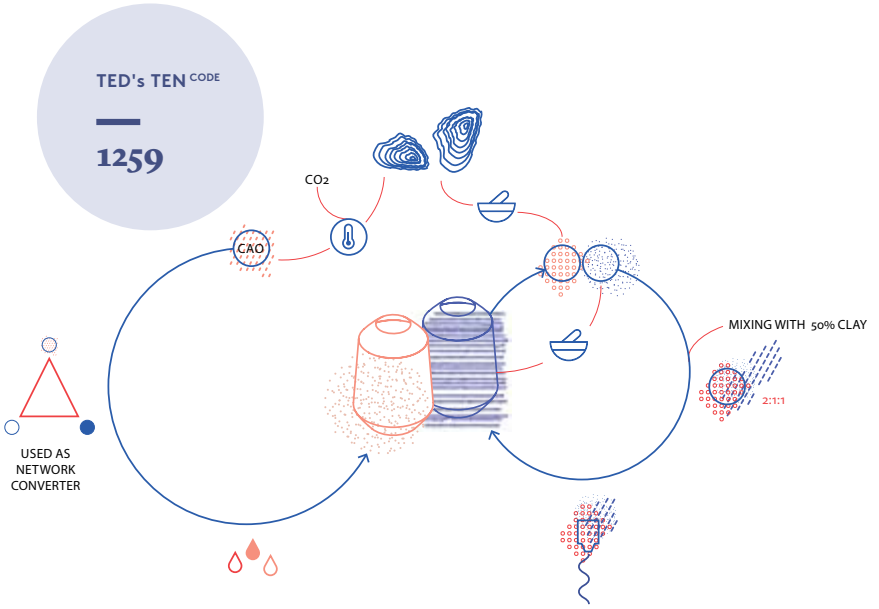
How might we use ceramic processes to unite two waste products from different contexts, resulting in a sustainable materials cycle?

Thalea Schmalenberg

The fascinating shell matrix of the oyster grows from its so-called **epithel** epithelial cells. These excrete calcium, carbonate, and conchiolin in various formulations: Two materials which by synthesis form the resistant shell.

Analogous to this phenomenon, traditional ceramic processes and the new, generative technology of 3D- printing give two waste materials a meaningful route of recycling: the lime from oyster shells and ceramic fractures, which in combination result in unexpected, formal-aesthetic as well as haptic qualities. The chalk of the shells, fired to produce calcium oxide, forms the main component of the developed glazes, which result in a wide spectrum of shades due to the different compositions of the raw material. The oyster-shell-based glazes create an visual and tactile contrast to the built up surface structures of the printed material synthesis.

Through the objects on display, the project Epithel emphasizes the beauty of the two waste materials on an aesthetic level and gives them a second and sustainable chance at life.



In which material qualities can brown algae be transformed?

Juni Neyenhuys

AL G. – Transformation of the Brown Algae

If there were Olympic Games for the life cycle assessment of raw materials, brown algae would surpass all conventional resources – in every discipline. Why? They require neither arable land nor irrigation, as they grow in salty coastal waters. There they also help reducing the nutrients surplus caused by agriculture and above all our CO_2 emissions. Furthermore, they grow very quickly. The main components of the algae are the polysaccharides alginate and cellulose. When the alginate is extracted, it offers a wide range of textile applications. The remaining cellulose can be transformed into a stable and light composite material. The project investigates the potentials of an integral utilisation of brown algae. This makes up a closed cycle - from ecologically useful cultivation, through recycling and use, to recycling.

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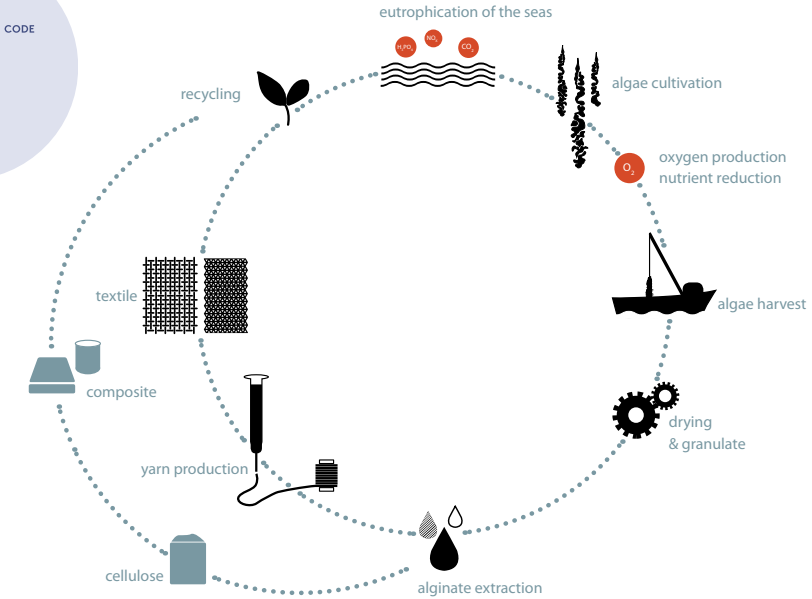

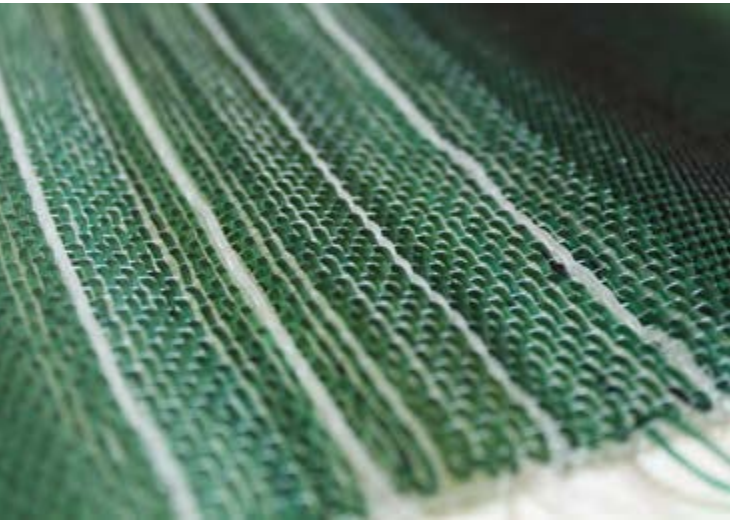

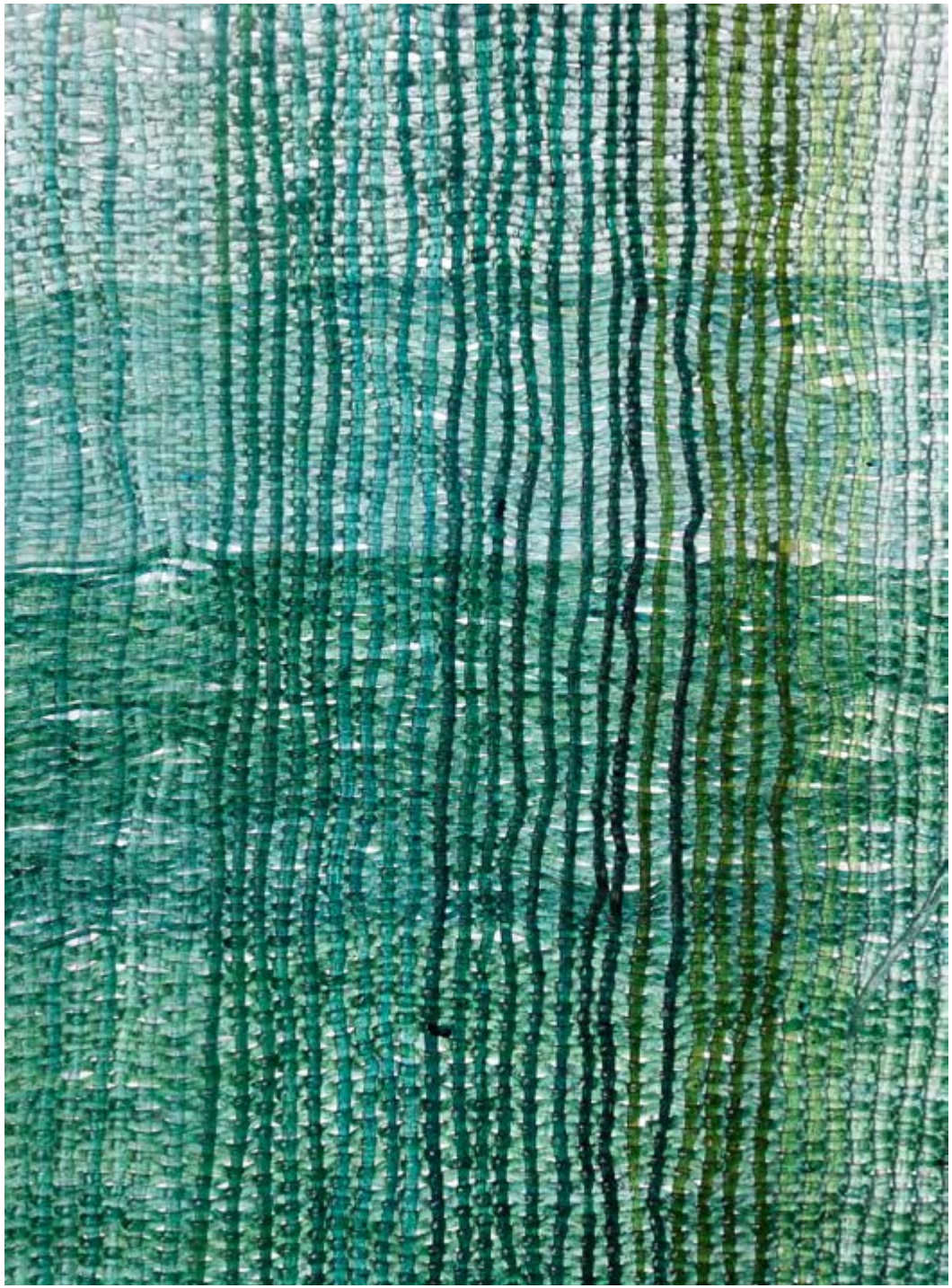

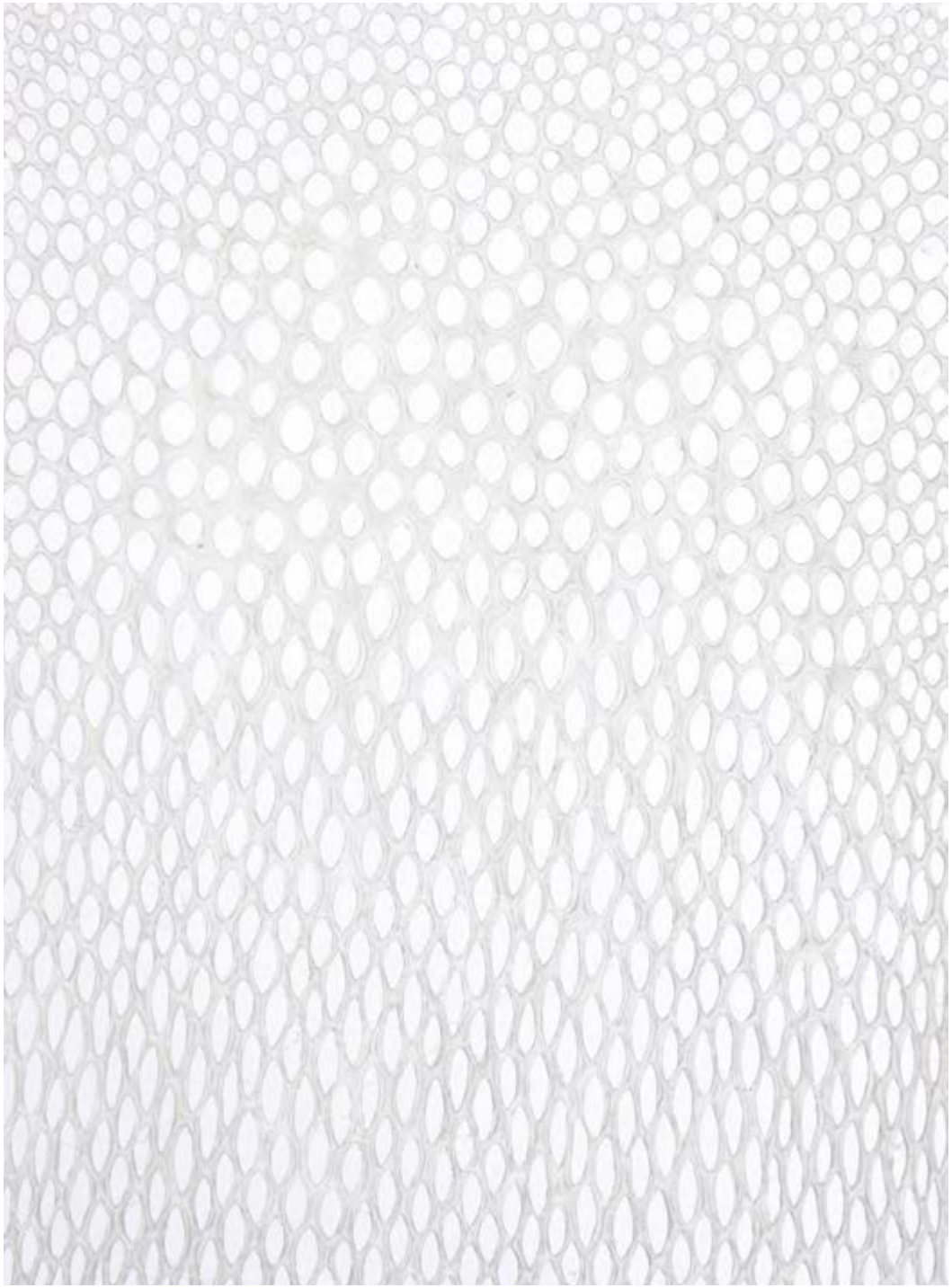

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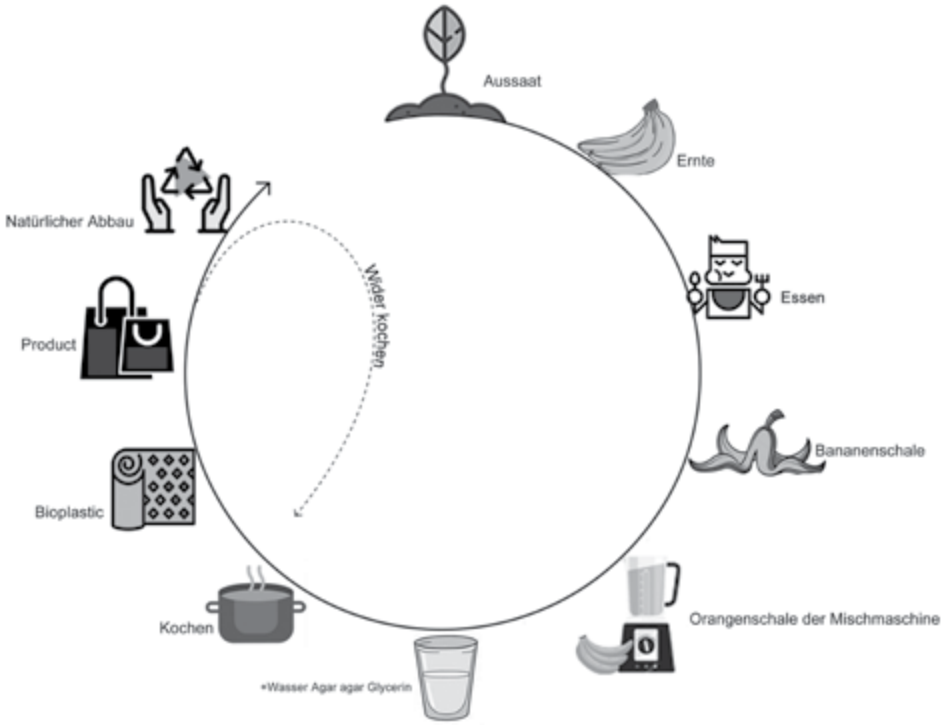
1256

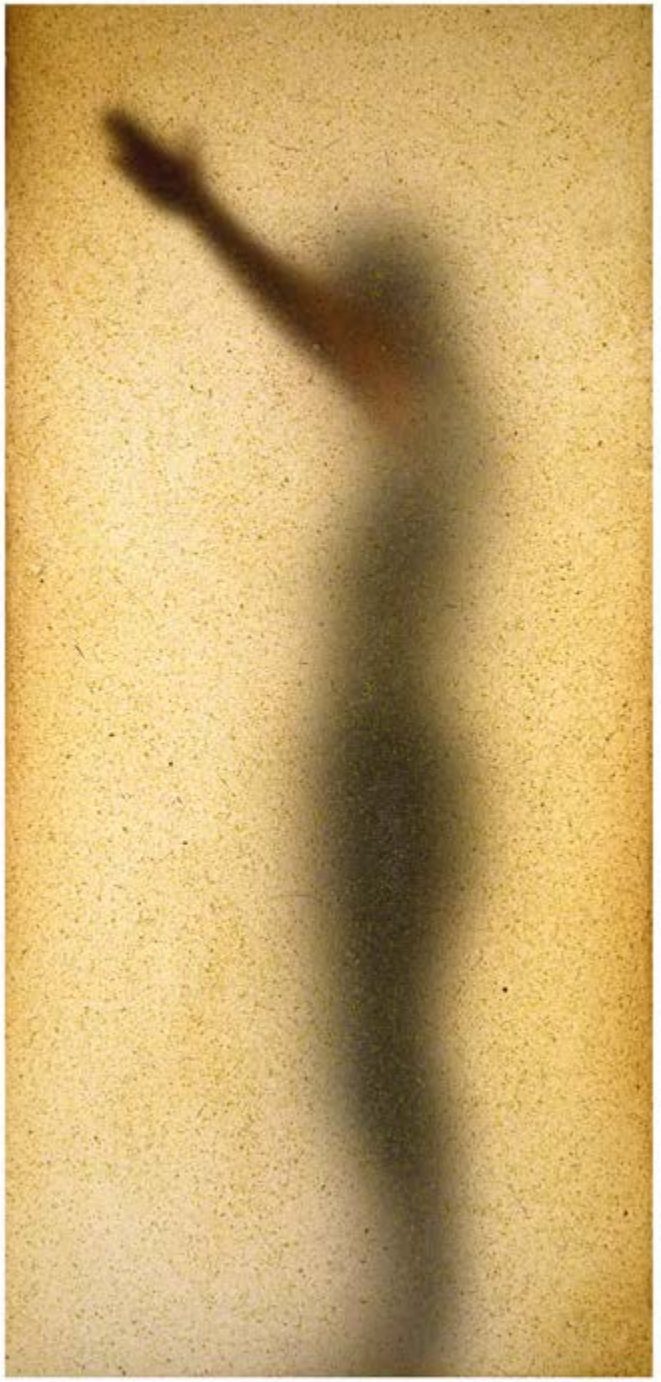
How can we create a new material from bio-waste that has the potential to replace animal leather?



Youyang Song

Cooking New Materials

Cooking New Materials is based on a self-developed process that allows organic waste to be processed into flexible, leather-like materials. Banana and orange peel or soya bean rests from soya milk production are combined using a natural binder as a matrix. The resulting composite material can be easily reused by re-cooking. It is a 100% biodegradable, zero waste natural product that also opens up whole new design possibilities.



TED's TEN^CODE

1278

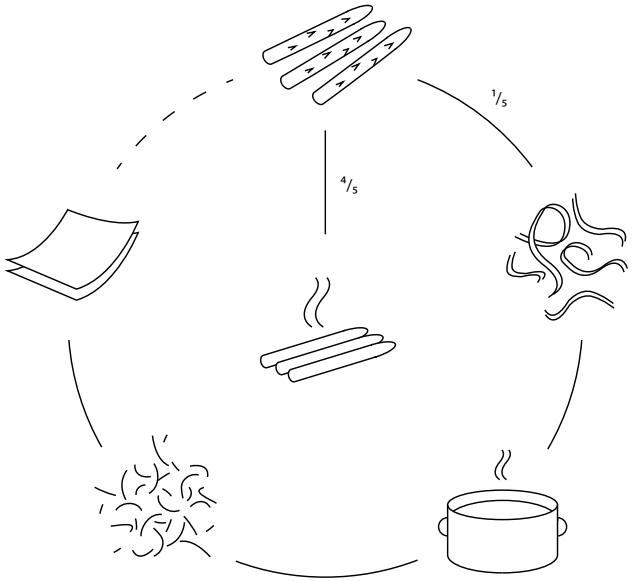
Does organic cotton make a t-shirt
a sustainable piece of clothing?
Can design change our consumer behaviour?
Is longevity a value in and of itself?

Henriette Dresbach,
Anna-Lea Hebeisen

Long Live the Cloth

Our designs are part of the wider discourse on sustainability and represent the beginning stages of our work with the aim of raising consumer awareness while at the same time promoting the longevity of clothing. Our key design elements are the quality of the material, the timelessness of the patterns, the possibilities for re-use and the effective communication of these principles. Two complementary collections resulted from our work: The 'Basic Wardrobe' uses classic basic patterns, while the 'Seasonal Pieces' were created by free draping directly on the mannequin. Both collections share a largely waste-free production process. Not only can they be worn in combination, but they are also connected via the material cycle. Our aim is to promote the underlying philosophy expressed in our clothing through an accompanying information and training programme.

Asparagus peel leftovers can be processed into a stable material without additional binders.



TED's TEN[CODE]

12

Anton Richter

What looks like wood chips or straw at first glance, reveals itself as asparagus shell. During drying, the white and soft peel has turned into a brownish and durable material with wood-like properties. With the suitable processing, a fibre composite material can be produced which consists entirely of asparagus shells, as they don‘t require any binder, due to their natural bonding properties. The particularly long fibers also allow a high degree of flexibility and stability. Both, surfaces and 3D shapes can be pressed, modeled and folded. In spite of its robust nature, the material is easy to dissolve and can be returned into its natural cycle.

100%

With circularity in mind, how the value of the urban nettle as a „super plant“ and local resource be re-established by employing design methods?

Tau Pibernat

Our Local Nettle

Our Local Nettle is a collection of recipes and experiments dedicated to the various uses of the stinging nettle. For many, the nettle plant is simply a weed, but in reality this "super plant" offers multiple nutritional and medicinal properties, in addition to its legendary qualities as a locally grown cellulose fiber for the production of textiles.
As an open, interactive lab, Our Local Nettle re-interprets the image of this urban plant, and motivates people to take advantage of nettles as a local resource, integrating them into their everyday life. Throughout the project, food recipes and design practices were collected, invented and tested. From "nettle-ade", to nettle paper, extraction of fibers and yarn plying, nettle cordage, screen printing paste and nettle ink. Furthermore nettle can be turned into a nutritious (biological) garden fertiliser. Thus the re-discoverd versatility of the stinging nettle has unveiled a great potential within the current ecological crisis.

TED's TEN^{CODE}

125610


NETTLE
STORIES
OUR LOCAL NETTLE

Re-composing the smallest particles of wood enables us to rethink the design process with this common material.

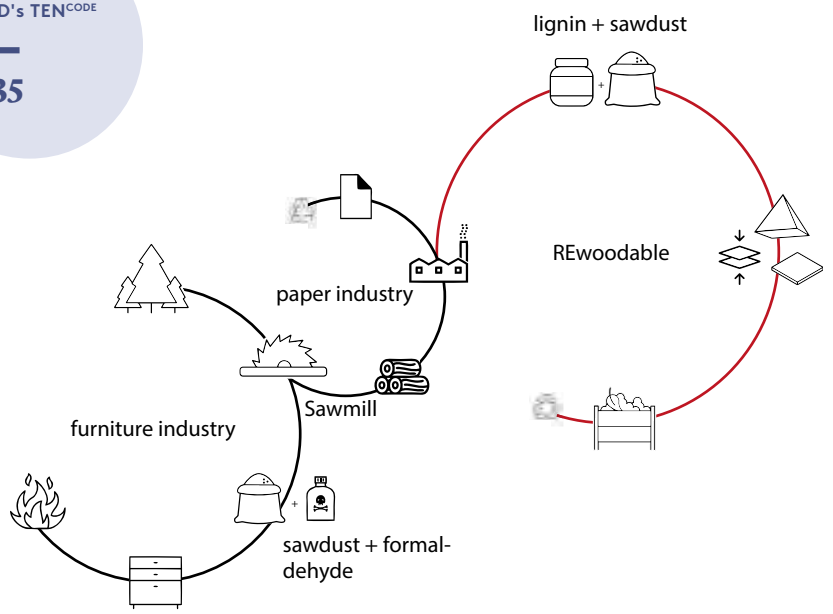
Nicole Dietz,
Tilman Holz,
Esther Kaya Stögerer

REwoodable

This project is about the development of a freely mouldable wood material, which, unlike the typical wood composite materials (MDF, OSB and chipboard), consists exclusively of components of the tree that are by-products of its industrial use. These components are on the one hand the sawdust and wood chips from cutting waste, but also the lignin, which is dissolved out of the wood during the paper production. Using lignin as a binder, an ecological plastic material is created that can be 3D printed or compression-moulded into any shape. By adding natural rubber the properties of the material can be augmented, making the wood more flexible.

TED's TEN^{CODE}

235



How can the unique materiality of bioplastics be transferred into a design language?

Nelli Singer

Transitional Textiles

In order to investigate bioplastics and their material qualities, experiments were carried out with the algae components carrageen, agar and alginate. By mixing and cooking various natural components, materials with varying exibility, tear resistance and transparency were created. Unlike normal plastics, they can be melted down again and again without any problems. They also can be glued together simply by moistening. The material behaviour of these bioplastics already offers inherent design possibilities. For example, wrinkles or crumpling can cause the resulting films to turn white in certain areas. Another discovery was that through the addition of sodium bicarbonate, the material developed a kind of floral texture. Several design options were combined in the project, e.g. additional perforated patterns cut into the films, through which the material opens or closes upon contact. The material cut into strips was also woven, using the possibility of bonding to create different densities and transparencies.

TED's TEN^{CODE}

12345

How can tea waste extend its useful life as a source material for other disposable products?

Lin Hsin-Ju

Tea Chain Reaction

Asian tea house chains not only serve plenty of tea, but also generate a lot of waste every day. The tea house chains are also seeking a unique and easily identifiable visual identity, reflected in their interior design and product packaging. The starting point of this project became the aim of integrating these seemingly independent themes within a sustainable design concept. The aim was to design a visual representation for the company which embodies all sensual qualities of tea: its look, texture, and fragrance: the results of the project take the form of panels and paper-like materials. Tea waste, processed into wall panels, can contribute to a muted sound atmosphere and a warmer ambience through their texture and color. Papers made from tea waste can be used for printing or packaging – the pulp can be created with different mixtures and procedures, and assume 2- and 3-dimensional forms.

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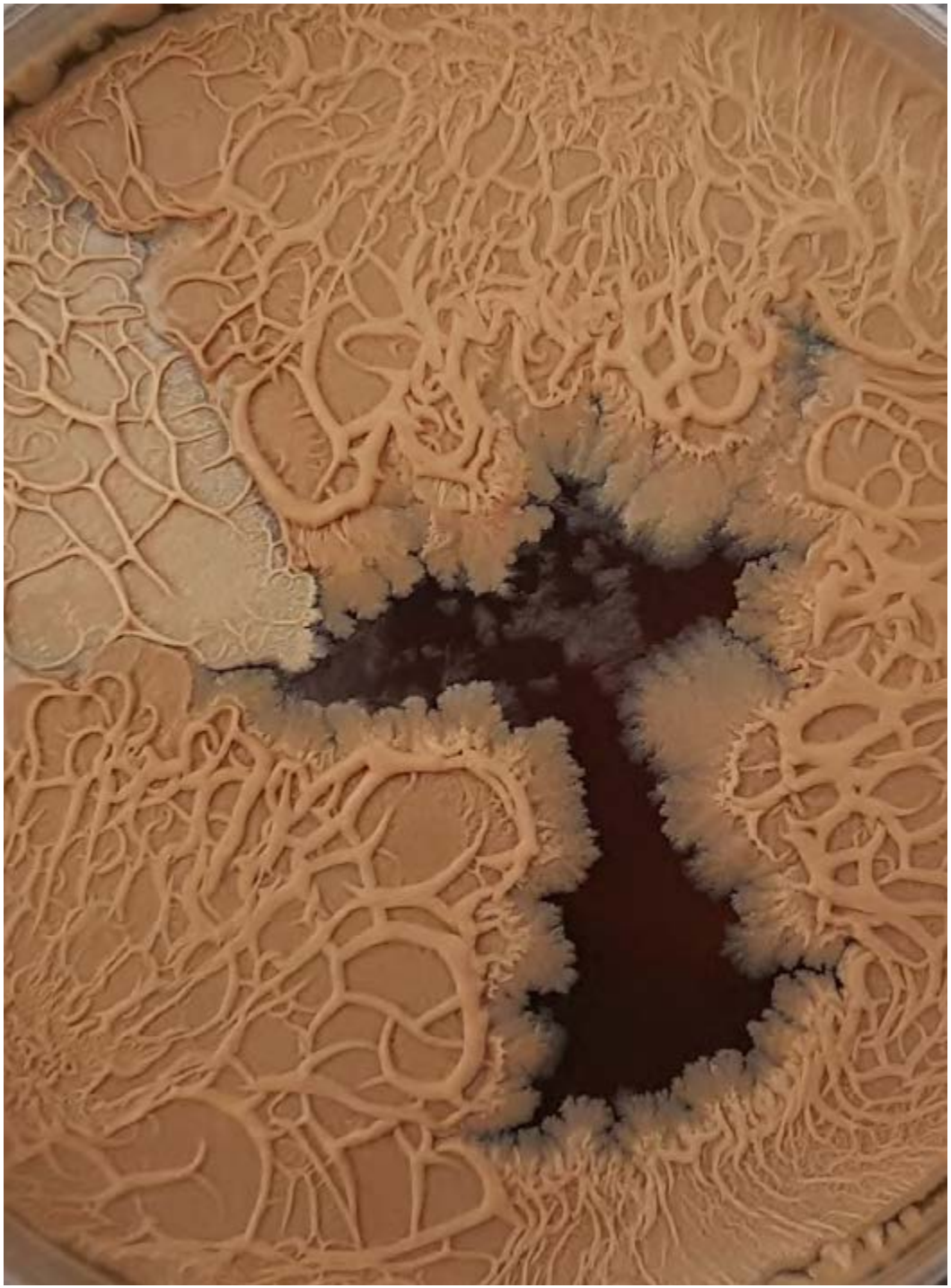


TED's TEN[CODE]

1510

How can we raise awareness for the wide-ranging potential of fungi and explore its possibilities as a sustainable material in circular production systems?

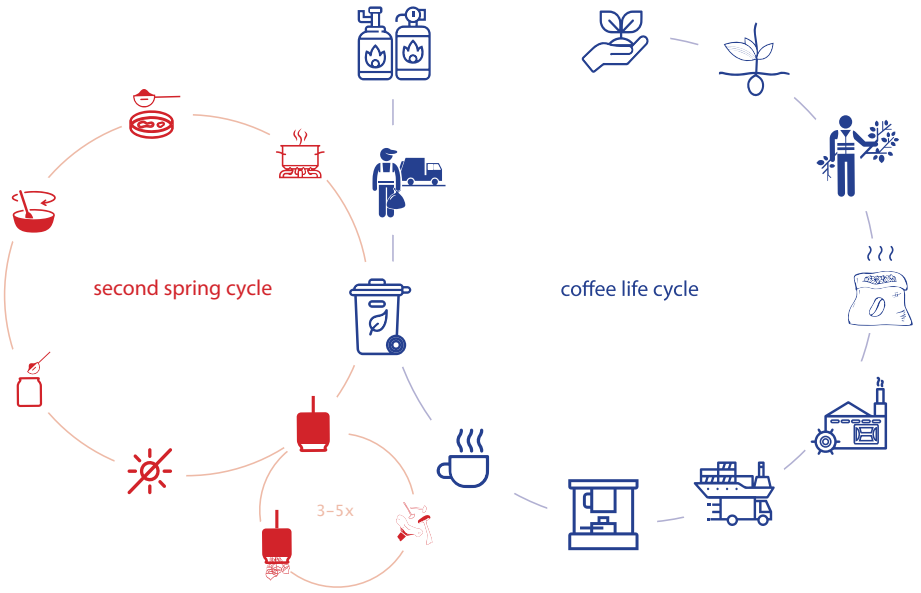
Jan van Riesenbeck

Second Spring

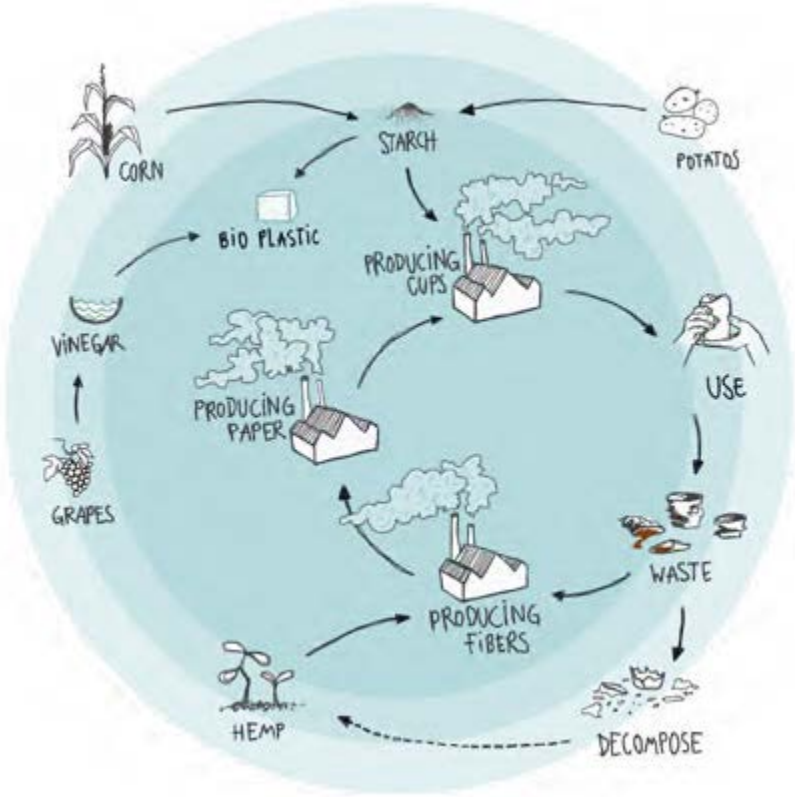
Fungi have both a visible and an invisible life: the mushrooms above-ground, and the mycelium, the nurturing and waste-digesting network underneath. In various projects it has been shown that both parts can be used to create durable and sustainable materials.

To gain experience in growing mycelium, I started experimenting with planting it on various substrates and researching their behaviour. The first outcome is a DIY cultivation tool kit for restaurants, cafés or private households that can be used both for growing edible mushrooms and recycling organic waste, through which the waste experiences a kind of 'second spring'. The project aims to raise awareness for the multiple functions and potential of fungi within individual and industrial contexts.

It is also serves as a starting point for an ongoing investigation of their material aspects and potential within circular production systems.




cup
to grow
cup
to grow



TED's TEN[CODE]

1234510

Johanna Ewert

Cup to Grow

With our current consumption of disposable cups and a recycling rate of less than 1%, it is time to develop a container with a small environmental footprint that requires no extra recycling system. The idea is a biodegradable hemp fibre cup that needs no plastic lid. Compared to wood paper, hemp paper can be recycled almost three times as often. In addition, hemp requires less cultivation area and is completely free from pesticides. The cup to grow is constructed using potato starch as glue and to save material, it does not require an extra lid. The cup folds shut leaving a small opening at its edge that is perfect for drinking. To make the paper water-repellent it is coated from the inside with a bioplastic made of cornstarch and vinegar. This coating is water-soluble; after approx. 40 minutes the moisture begins to draw into the paper. The final step is the easiest. Simply recycle with your normal paper or better yet, just compost it.

How to transform waste paper into a new useful material?

Tim van der Loo

The Paper Waste Workshop is an open source mobile laboratory that invites everyone to join in, experimenting with and developing new biodegradable materials from local waste in combination with natural resources. At this stage we use an ubiquitous material, which we rarely consider recycling: the paper posters spread all over urban spaces, including Berlin, announcing the events of the next day. These short-lived and attention-grabbing media build up into multiple layers amount to an enormous bulk of paper on fences, public walls and advertising columns.

The Paper Waste Workshop

By peeling away the layers of posters, thereby revealing the 'tree trunk rings' of these urban surfaces, we source the main ingredient for the new material – one which is easy to manipulate by adding basic biological ingredients and using simple kitchen utensils. The result is a mouldable clay-like mass, purified from the chemical print dye stuffs, from which it is possible to form sculptural or peculiar objects for everyday use. This cellulose-based substance, before it has dried, can also be used to join things together thus replacing the need for chemical glues.

TED's TEN^{CODE}

12510


THE PAPER
WASTE
WORKSHOP

What is more natural than the cycle of life and death?

Julia Heldner

131

MICLL

As a kernel of ash, filled with memories, I lay down, come to rest and settle. Comfortable it is, as then as an embryo. I am a unique sleeping piece in a supernatural construct of transformation. My vapour clings to the jelloid substrate of the future - fantastic. We symbiotically form the basis for natural growth. In the root system of the plant, my silent breath flows, finally I become one with my special cover. Transience is the new longevity and a constant of change.

TED's TEN^{CODE}

36

What do we want to produce in the Plastic Age & how can we transform today's materials into something better?

Jannis Kempkens

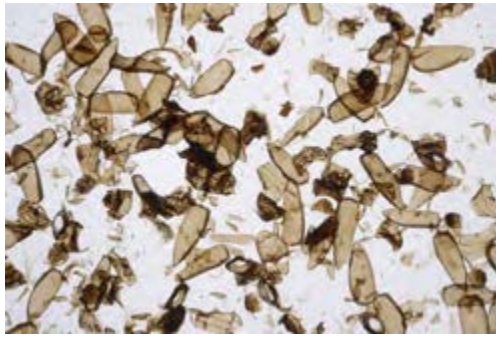
Plasticula

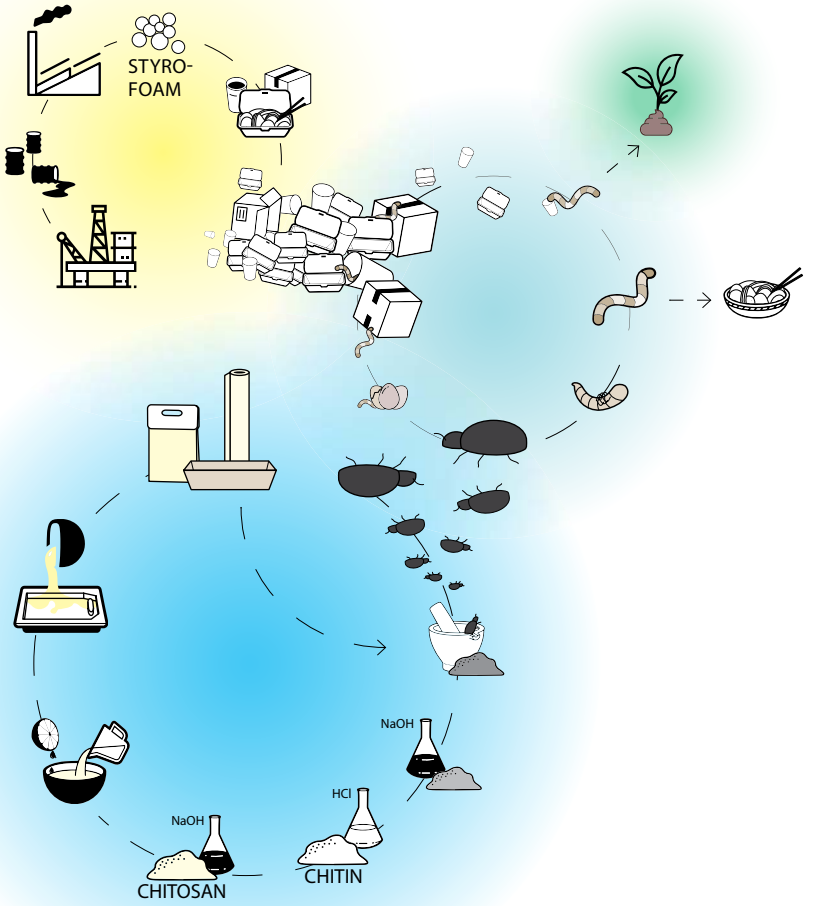
We learned that the mealworm eat polystyrene when a Californian couple kept their worms in a styrofoam box. Studies have since shown that worm and plastic can form a perfect symbiosis, in which the worm extracts all the necessary nutrients from the foamed plastic and transforms it into a biologically usable mass. The same worm is also a high-quality source of protein and already regularly ends up on the plates of a third of the world's population. But what else arises in its life cycle when the larvae grow, pupate, become beetles and eventually die?

Plasticula is dedicated to these remnants, which consist mainly of chitin, and shows how they can be transformed into new materials. The main intention of this project is the transformation of an otherwise harmful plastic, which is transferred into new sustainable cycles and simultaneously dissolved.

TED's TEN^{CODE}

356




STYRO-
FOAM
NaOH
HCl
NaOH
CHITOSAN
CHITIN

How can furniture be re-considered as part of the material cycle?

Sion Heo

ReRecycle Various types of recycled paper are shredded into small pieces and processed into a plastic mass, which serves as a base material for furniture, objects and sculptures. The only extra ingredients are water and household flour. When the object has been formed and dried, the surface can be finished accordingly. In this case, the process is demonstrated using a design for a stool. The focus in not only on the material, but also the stool's construction, which successfully combines light weight with stability. If a piece of furniture is considered not as an end product, but instead as part of a material cycle, it takes on a new character. It becomes part of both nature and culture, is both cheap and precious, robust and fragile. Total material cost: less than 1 Euro.

TED's TEN CODE

125

GreenDesign$^{7.0}$

shaping futures: material flows and human economies

Prof. Dr. Lucy Norris

In the north Indian textile recycling industry, brightly coloured blankets are woven out of the wool and acrylic fibres reclaimed from imported old winter clothing.

Shaping Futures: Material Flows and Human Economies
Prof. Dr. Lucy Norris

Anthropology, like design, is a practice-based mode of thinking in, through and about the world, a discipline in which empirical research into the way people think and act is the fundamental cornerstone for building theoretical understanding. As the study of what it means to be human in the world, its core approach is often summed up in the phrase 'to make the strange seem familiar, and the familiar seem strange'; in other words, to challenge our assumptions and find out how people from 'other' backgrounds, societies and cultures are similar to each other in their values, beliefs and behaviours, and how they are different.

The research methods we use are diverse, but they often include ethnography: simply put, spending time simply hanging out with small groups of people, joining in what they do, watching how they behave and asking a lot of questions! As anthropologists have become increasingly interested in how people try to shape their futures and build new ways of living in the world, the ties between the disciplines of design and anthropology have been strengthening in the past few years.

Anthropology contributes to our understanding of how different people conceive of the world without imposing our own categories on them. Looking at another group's way of doing things also helps us to question our own attitudes and behaviours that we often fail to see. Design anthropology combines these approaches in order to understand how we grow and become who we are as social beings through our engagement with the material world, not only as users, but as makers, craftsmen and designers, creating materials, fashioning things and building systems. The anthropology of design also studies the social, economic and political frameworks in which designers work as future-makers, what their worldviews and visions are, and how they understand their potential as shapers of change.

Discarding in India: contexts of waste and value creation

My research in north India focussed on what clothing and textiles mean to people 'off the body', and how their materiality is implicated in the ways in which it is used and reused as it is exchanged in families, households and second-hand markets.[1] Textiles can be understood as a combination of materials and techniques, coded narratives and repositories of memory, key to creating social relations through the way in which they are valued, and replete with latent potential for future incarnations. Thinking about them not as finished goods, but as the integration of matter and energy flows at a particular time and place, flows of which we are all a part, allows us to perceive the human element in material cycles, and understand how we value some things over others, and when things become 'waste'.

Mary Douglas famously claimed that »dirt is matter out of place«.[2] She shows how dirt is something that disturbs order - it fails to fit into the cultural categories we create. Dirt threatens to destabilise our world and must

be got rid of. In this sense, contamination is not primarily physical; it is rather a reaction to social disorder. Sorting, ordering and valuing the things we live with are essentially rituals of purification, and ridding ourselves of stuff is routine. 'Dirt' is an unavoidable outcome of all human activity, and all societies create dirt, or waste – as Douglas also wrote, »where there is dirt, there is a system«.[3]

We make dirt invisible by pushing it out of sight, out of mind. We live in a global economy, and the recycling of wastes often happens far away from where things are produced or consumed. So in order to design better products, keep materials circulating and really reduce the amount of rubbish we burn or bury, we need to make dirt visible again, to make the system transparent, and understand how it is created, traded and repurposed, and give a voice to those who work with it.

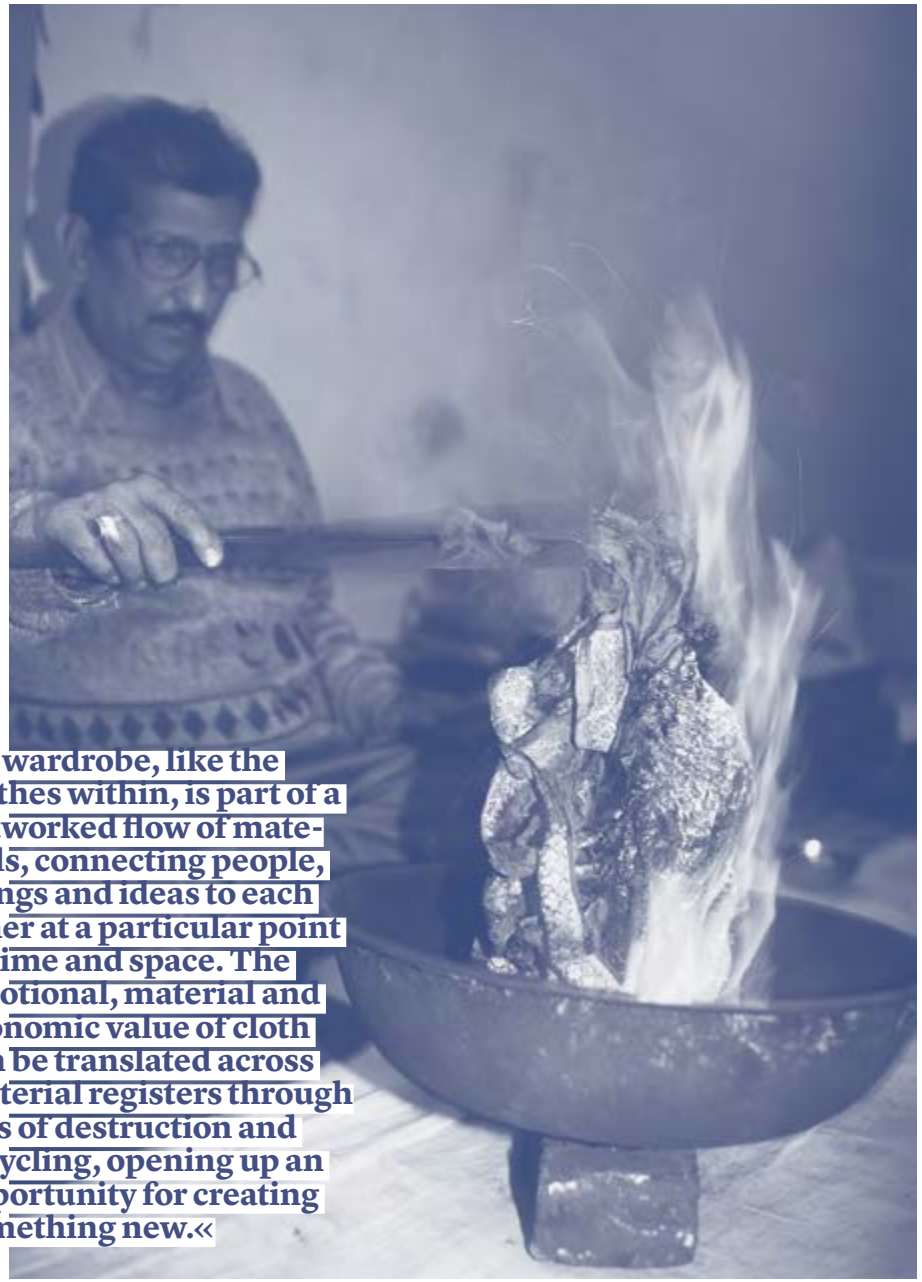
As Michael Thompson explains in *Rubbish Theory,*[4] the value of objects tends to decline over time (transient), but it is not until we re-classify them as waste that someone else can rescue them, and their potential can be recognised and transformed into durable value. How this happens is both culturally specific, and linked to power structures, as he writes:

»Those people near the top have the power to make things durable and to make things transient, so they can ensure that their own objects are always durable and that those of others are always transient... Step outside these limits and one sees the boundary between rubbish and non-rubbish moves in response to social pressures.«

During research in a middle-class suburb in New Delhi, India, I quickly discovered that clothing is an important part of a household economy that was never thrown away and never ended up on rubbish dumps. It is a resource that people were strategic with, controlling the flow of material in and out of the household, and using cloth up until it completely disintegrated. Clothing is part of a complex cycle of gifts between family members, and women in particular are given clothing throughout their lives, beginning with a trousseau. But in large, extended families, clothing could be treated as a joint resource. So the contents of a wardrobe may not 'belong' to an individual, and may not reflect an individual's choice or taste.

More traditional Indian clothing can be easy to adapt - saris wrap around bodies fat and thin, young, pregnant and old. Tailored clothing is made with wide seam allowances that can easily be let out. Clothing passes from old to young, and is often given to servants until it gets too tatty, when it is cut up and made into children's clothing or used around the house. Clothing was just one stage in the life of a piece of cloth brought into the house, and every type of material had its uses, as floor cloths, covers, wrappings, depending on its material qualities.

The wardrobe is a technology of household thrift, an endless resource for creating new value from transient textiles. We can also think



»A wardrobe, like the clothes within, is part of a networked flow of materials, connecting people, things and ideas to each other at a particular point in time and space. The emotional, material and economic value of cloth can be translated across material registers through acts of destruction and recycling, opening up an opportunity for creating something new.«

Fig. 1 A precious metal dealer in Old Delhi burning an old silk sari to reclaim the silver from its decorative thread.

Fig. 2 Over 100,000 tonnes of cast-off clothing is imported into India every year for recycling into shoddy yarn for the local textile industry and export markets in Africa.

of it as a node in a networked flow of matter and materials, connecting people, things and ideas to each other at a particular point in time and place. It is a collection, a microcosm of social relations, part of much larger scales of circulation, and, just like us as social persons, it is in a constant state of flux.

However, the growing wealth of the middle-classes has led to overflowing wardrobes, and people don't know what to do with the excess of clothing they are gifted. Old clothing can be bartered for shiny, stainless steel pots – migrant women from Gujarat would regularly visit a neighbourhood, and offer one or two pots for a pile of old clothing. The absence of money helps to smooth the way for women to let go of old clothing, and acquire pots to display in their kitchens.

Saris and pots are both typical trousseau gifts when a couple gets married, and both are an essential part of the assemblage of people, objects and materials that make up a family household. Both the interwoven threads of a piece of cloth, and the moulded form of a clay or metal pot are both symbolic of wrapping, containment and wholeness.

Understanding the cultural and symbolic resonance between things can be useful for creative insights into how and why materials circulate in societies, and what the triggers are for translations of value between different circularities.

The Gujarati women dealers then traded the clothing every morning in a wholesale market in a Delhi suburb. Here a grassroots sorting system of over 3,000 micro-entrepreneurs made sure that the clothing was washed, repaired, and mostly sold on to markets in poorer, rural areas, with a few niche upcycling markets developing for 'airline saris' or 'silky saris' to be made into tourist clothing. But although the vast majority of clothing slides down the social hierarchy, the most valuable silk saris, woven with real gold and silver threads, are quite a problem to get rid of. Women often said that they were too good to give away to their servants, but not good enough to be worn again, and they begin to accumulate in suitcases under beds.

For those who know where to go, there are still dealers in Old Delhi who will weigh a silk sari decorated with gold or silver thread, to test if the metal is real, and offer you a price for it. The dealers then burn it in a crucible (FIG. 1). So the cloth is transformed into gold and silver, and these metals are refashioned by the goldsmiths nearby into jewellery or thread that will likely be gifted in another cycle of weddings.

Global flows of used clothing

Ethnography affords insights into other people's ways of living, but it can also unexpectedly shed light on our own through research into materials. In another project in the town of Panipat, northern India, I researched the stories behind the piles of used clothing imported from around the world as raw materials for producing recycled yarn. These piles towered

high in warehouses across the town, the clothing sorted into groups by colour (FIG. 2).

The travels of used clothing very quickly takes us from researching local cultures to global markets, and to understanding long reverse supply chains. At these different scales of circulation, stories that travel with materials are re-told many times over, and in the end are often not at all those we have told ourselves or expect to hear from others. The global second-hand clothing economy is a secretive and lucrative business, and depends upon the export of waste from richer countries to poorer. But for me, the most interesting part of the research into these circulations was finding out how the women working in the recycling factories make sense of the piles of old clothes they have to deconstruct. What do those piles tell them about us?

Well, according to them, as they sit in the piles of our stinking old clothing, Western women are free - we live lives free to make waste. The women scrutinize each and every piece of our discarded clothing before carefully ripping it to shreds, wondering why some looks almost new, and holding them up in amazement to show each other (FIG. 3). We see this in the film *Unravel*,[5] directed by Meghna Gupta, where Reshma and her co-workers repeat a widespread rumour that there is a water shortage in the West, and that it is simply cheaper for us to throw the clothing away than to wash it. It may not tell us the whole story, but it is surely an insight that should make us feel uncomfortable as we see the continued rise of cheap, fast fashion. In truth, most of us don't ask where our old clothes end up, we simply turn a blind eye. In fact, the clothes are then shredded, the fibres are spun back into yarn, and this is woven into shoddy blankets for the local market, or distributed by charities as disaster relief (FIG.4).

Perspectives on material cycles

We can make choices about how to reduce waste, but these are political and economic choices. And we need to acknowledge the fact that global economies depend upon the control of material flows; it is people who circulate materials, and by extension, they control other people's lives. It is crucial to understand the networks of power that underpin these flows, and to work for multiple solutions and open source initiatives, in order to build human economies that serve the needs of people and their communities.

In particular, we need to be alive to the politics of material monopolies, and nurture a diversity of materials openly available for use and experimentation. Claims that implementing the circular economy enables economic growth to continue unchecked without increasing resource use are being challenged by the de-growth movement, and more research is needed. To put it simply, as anthropologist Thomas Hylland Erikson urges in his book *Overheating*, »we need to cool down, slow down, scale down«.[5]

Fig. 3 Migrant workers in a recycling factory in north India cut up imported Western clothing piece by piece, before it is mechanically shredded to reclaim the fibres.

Material Ecologies: new concepts of the material world

We have developed tools that can re-shape the planet itself, a techno-sphere relying on the extraction, transformation and mobilisation of matter that has resulted in the Anthropocene, the proposed new geological age defined by the human footprint, and represented by the techno-fossil.

Tim Ingold suggests that we study 'the ecology of materials', bringing together the social study of objects and things with the ecological study of how we, as humans, relate to both living and non-living environments.[7]

This means including the living world in our conception of the material world, studying the circulations of materials that give rise to things and that constitute the web of life, and thinking about things as being connected to their source of vitality in flows of energy and materials, and respecting their capacity for generation, liveliness, perception and response.

Neri Oxman's concept of 'material ecologies' suggests that we impart a living quality to objects, buildings and cities that 'grow' rather than assemble.[8] Oxman's aim is to develop the relationship between built, natural, and biological environments by employing design principles inspired and engineered by nature. She draws on Semper's theory that the material practice of craft is informed by the troika of matter, its method of fabrication, and by the environment.[9] Ingold also uses this concept of objects growing when talking about a craftsman working together with materials, to weave a basket for example, or a piece of cloth; his phenomenological approach understands processes of making to be a modality of weaving, of bringing people and materials together in process.

Anthropology has long understood the fundamental entanglement of the material with social processes of human becoming. The broader current of new materialism resists anthropocentrism, and revitalises discussion as to how new understandings of the human, citizenship and politics emerge from taking the constitutive nature of material processes seriously. It brings a critique of nature-culture binaries and concepts of multispecies cohabitation into the frame, building a theoretical space in which to explore ideas about living organisms as materials. Given the focus in greenlab 2018 on the importance of design for circular systems, materials innovation and the emphasis on living materials and the bio-economy, thinking in terms of material ecologies may be a good place to start.

[1] Lucy Norris, *Recycling Indian Clothing: Global Contexts of Reuse and Value* (Bloomington: Indiana University Press, 2010).

[2] Mary Douglas, *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo* (London: Routledge & Kegan Paul, 1966).

[3] ibid.

[4] Michael Thompson, *Rubbish Theory: The Creation and Destruction of Value* (Oxford: Oxford University Press, 1979).

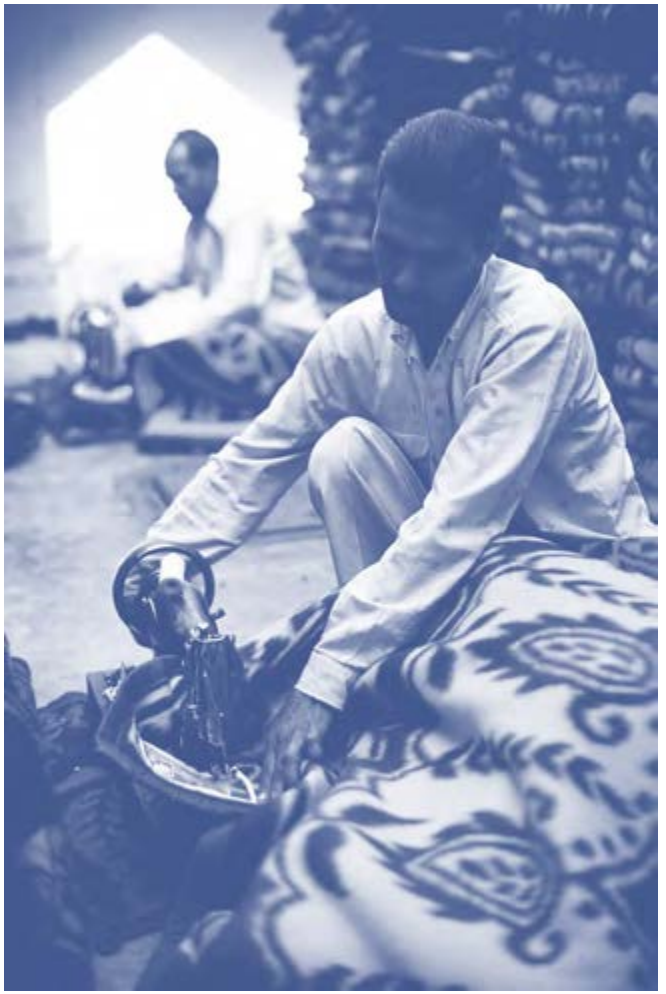


Fig. 4 Blankets woven out of recycled wool or acrylic yarn often have South Asian designs such as the Tree of Life, and are sold to local buyers.

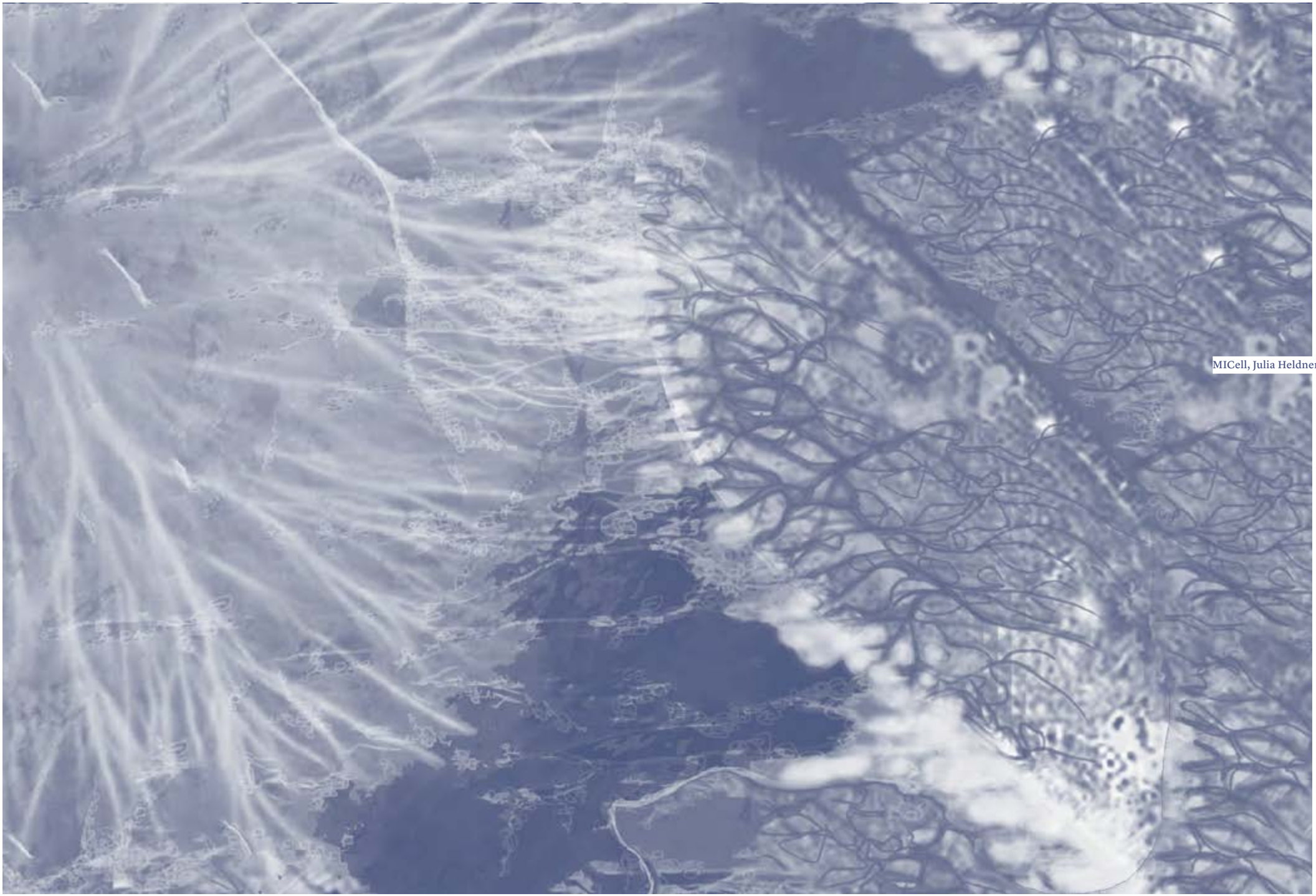
[5] Meghna Gupta, *Unravel*, Documentary, 2012, https://aeon.co/videos/this-is-the-final-resting-place-of-your-cast-off-clothing.

[6] Thomas Hylland Eriksen, *Overheating* (Chicago: University of Chicago Press, 2016).

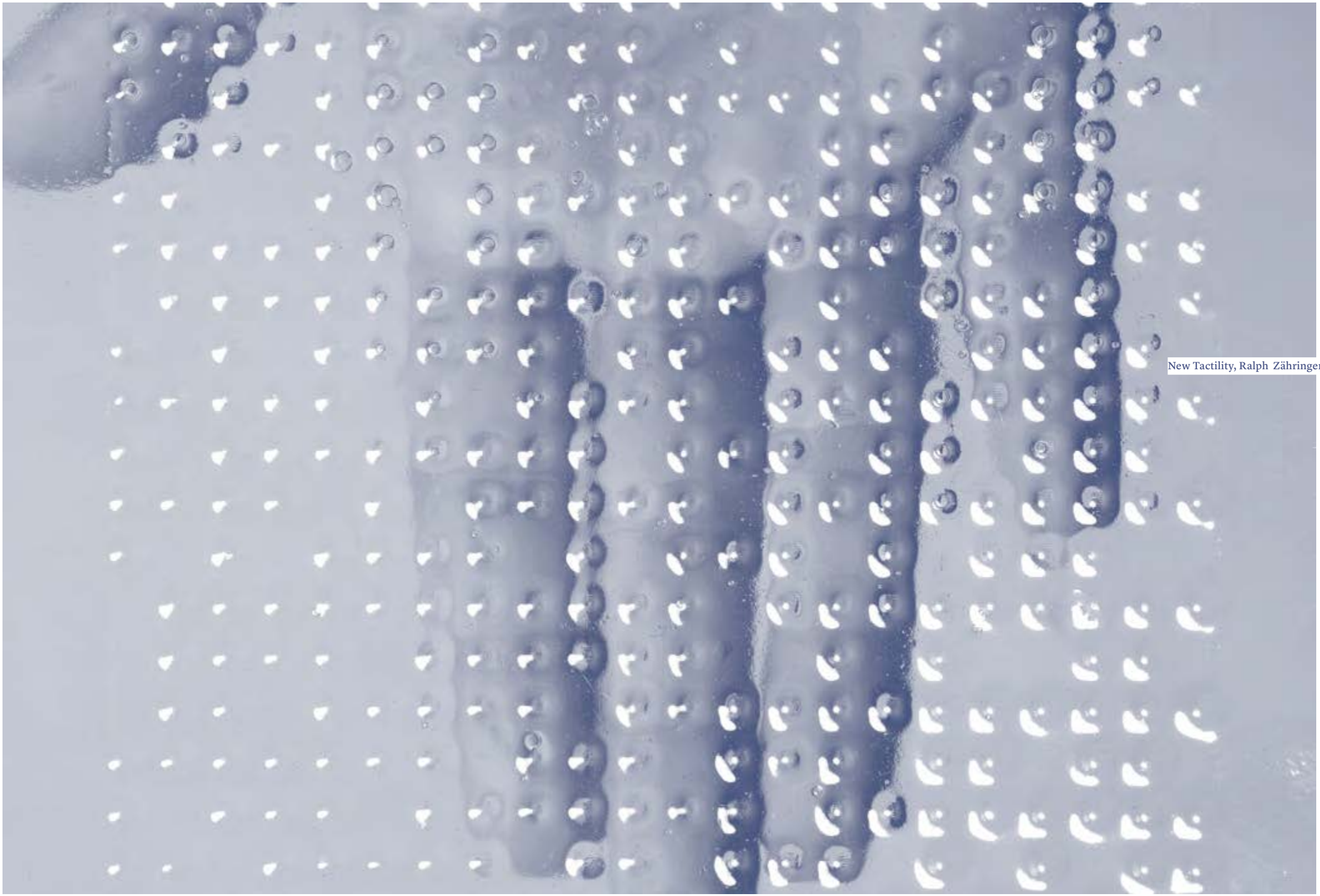
[7] Tim Ingold, 'Toward an Ecology of Materials', *Annual Review of Anthropology* 41, no. 1 (21 October 2012): 427–42, https://doi.org/10.1146/annurev-anthro-081309-145920.

[8] Neri Oxman, 'Toward a Material Ecology', in *Proceedings (32nd Annual conference of the Association for Computer Aided Design in Architecture (ACADIA), San Francisco, 2013)*, 7, matter.media.mit.edu/assets/pdf/Publications_ME.pdf.

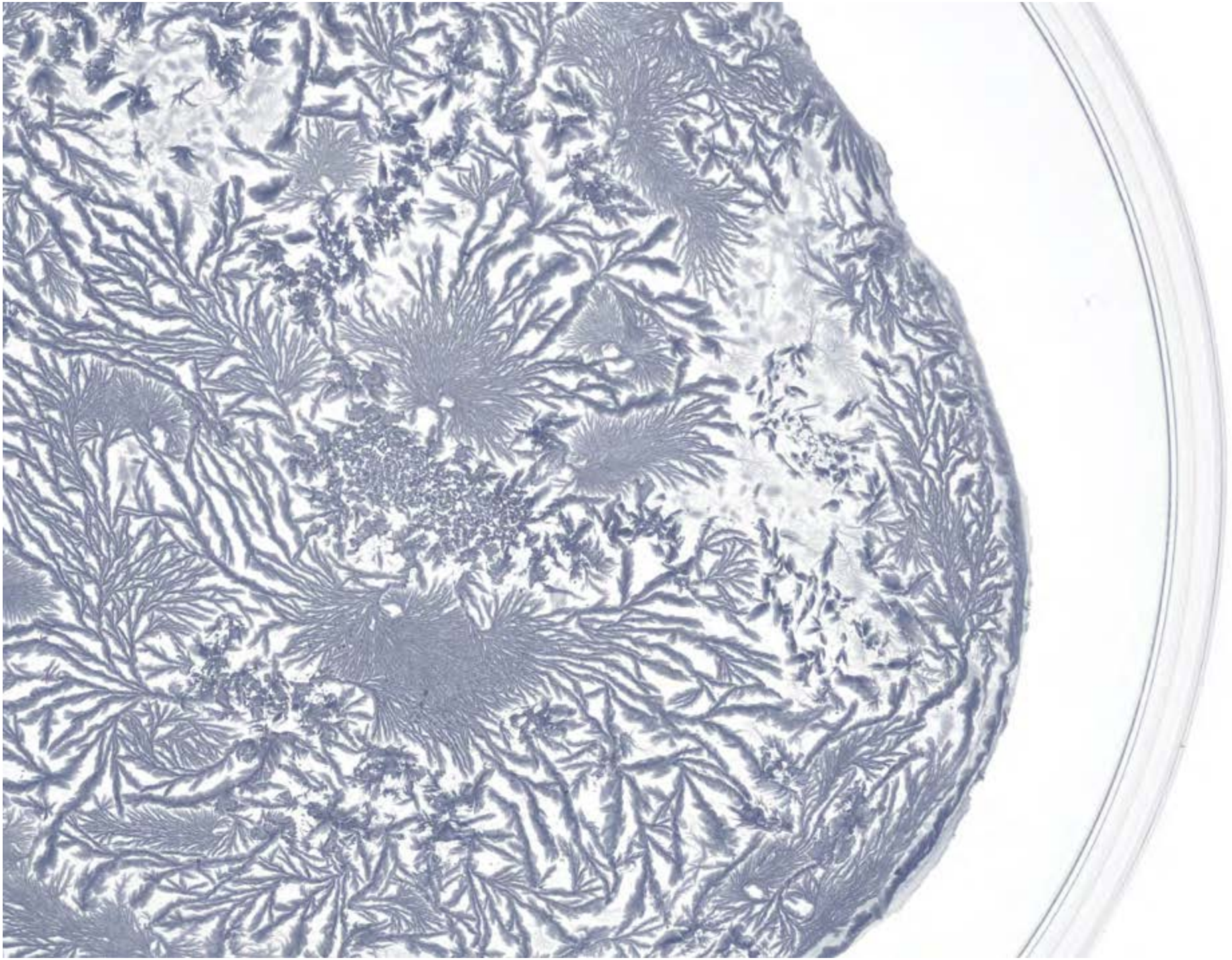
[9] Gottfried Semper, *The Four Elements of Architecture and Other Writings*, trans. Harry Francis Mallgrave and Wolfgang Herrmann, Reissue edition (Cambridge, New York, New Rochelle, Melbourne Sydney: Cambridge University Press, 2011) [1851]



MICell, Julia Heldner

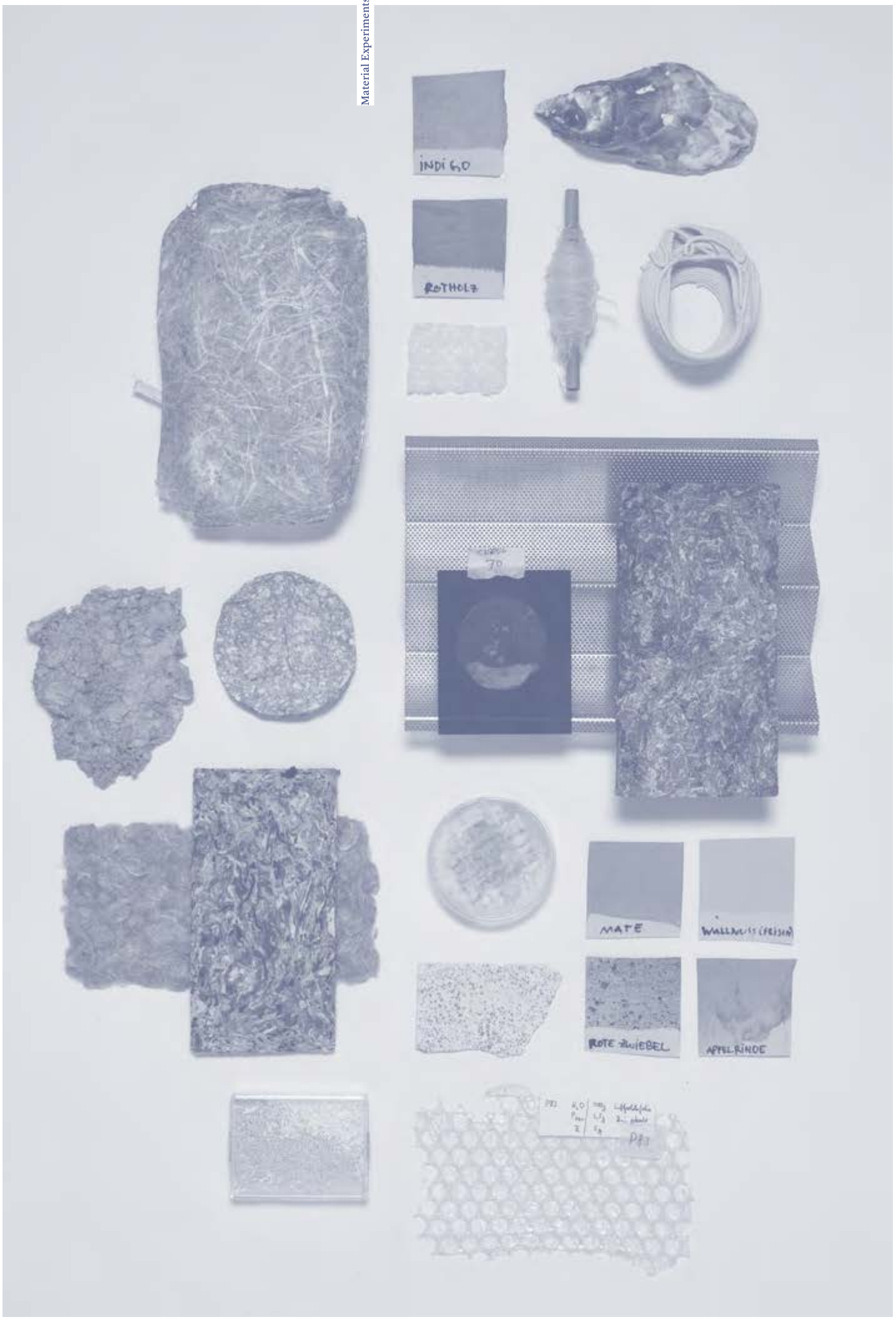


New Tactility, Ralph Zähringer



Transitional Textures, Nelli Singer

REwoodable, Esther Kaya Stögerer,
Nicole Dietz, Tilman Holz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