Microalgae as Raw Material for Textiles - AlgaeTex

Christoph Peiner – Institut für Textiltechnik (ITA) of RWTH Aachen University

AlgaeTex – Microalgae as Raw Material for Textiles

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BIOTEXFUTURE innovation space

We believe: The textile value chain can be converted from petroleum-based to bio-based

Achieving this vision requires:

- a **bio-based raw material basis for plastics** that is holistically sustainable
- the **application in the textile industry** from biopolymer (material basis) to the manufacturer of the complete textile
- the **overall societal transformation** towards a bio-economy from a social and economic perspective

BIOTEXFUTURE

Eine initiative des Bundesministeriums für Bildung und Forschung

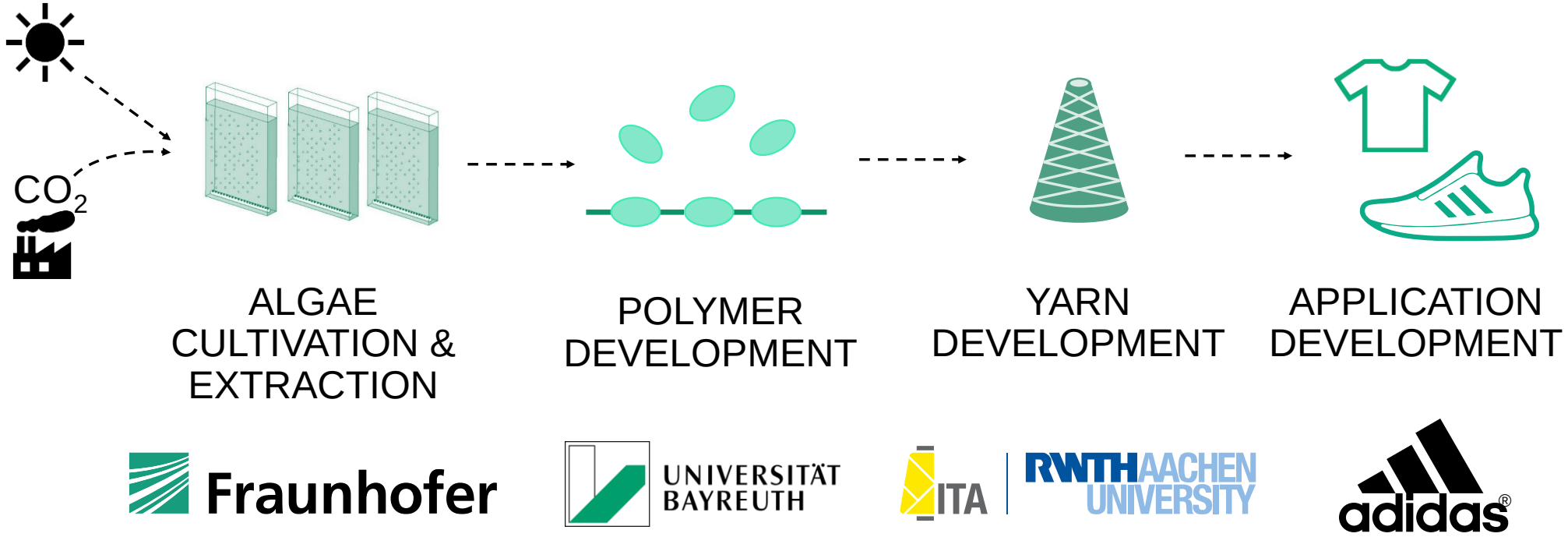
Wissenschaftsjahr 2020|21

BIOÖKONOMIE

AlgaeTex – A Part of the BIOTEXFUTURE Innovation Space

Can microalgae serve as raw material for the industrial production high performance textiles?

Our approach and our partners:



AlgaeTex – Microalgae as Raw Material for Textiles

Why using Microalgae?

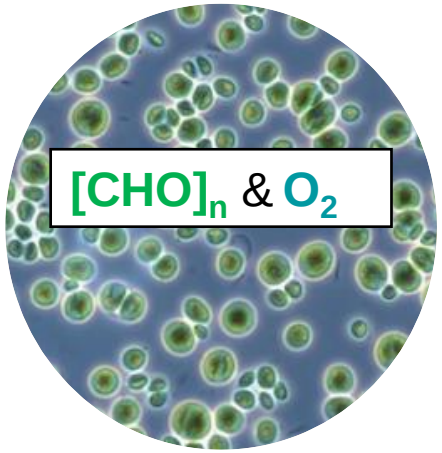
- Algae can use CO_2 as carbon source
- Can be cultivated on non-arable land
- Small water footprint
- Fast production whole year round possible

Photosynthesis

1.8 kg CO_2 → 1.0 kg Algae

Marine algae produce half of the primary biomass worldwide

- Chlorella vulgaris – used within the project AlgaeTex
  - with high fatty acid content
  - Fatty acids potentially usable for polymerization of bio-based plastics



Algae development at Fraunhofer IGB

- Development of new controllable photobioreactor
  - Usage of LED illumination for enhancing productivity relative to volume and land use
  - Examination of fatty acid content and fatty acid spectrum

Chemistry at Uni Bayreuth: Exploiting algae-based feedstock

Aims:

- Synthesis of polyamides and polyesters in **fiber-spinning grade** from algae-based monomers
- Synthesizing polymers with **maximum algae-content**

Our approach:

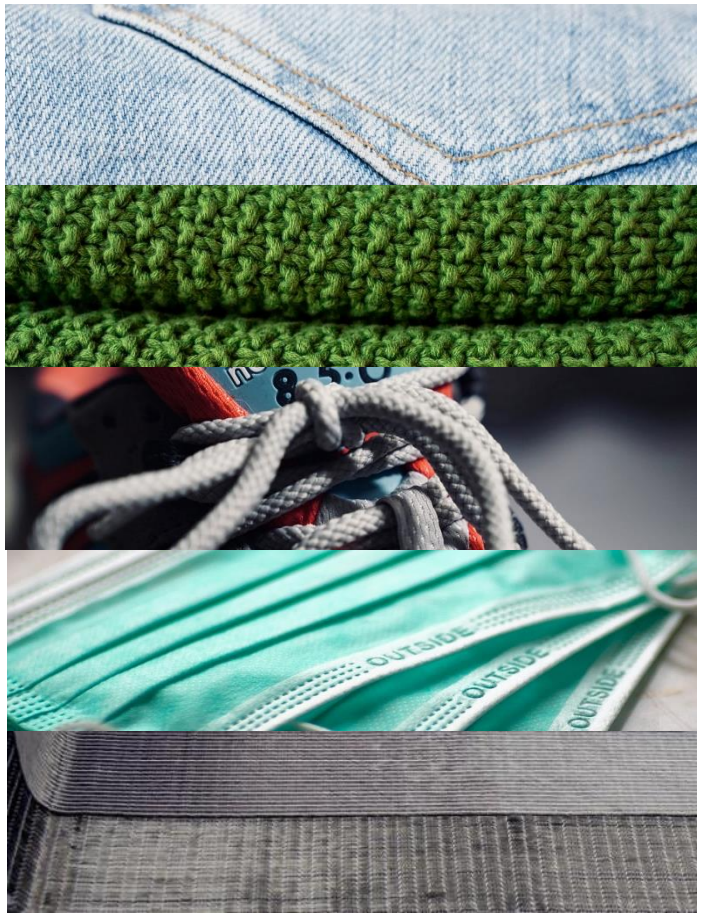
- Development of new synthesis strategies for the valorization of algae-oil (natural triglycerides)
- Synthesis of bifunctional building blocks (diacids, diols) from **F**atty **A**cid **M**ethyl **E**sters (FAME) derived from algae-oil following the **principles of green chemistry**

Fatty acid	Structure
Oleic acid	**C18:1**
Linoleic acid	C18:2
Linolenic acid	C18:3
Palmitoleic acid	C16:1
Palmitic acid	C16:0
..	

Textiles – fiber based structures

- 100 % of all natural construction materials are fiber based
- Textiles can be engineered to fulfil specific purposes
  - Solid and strong for reinforcement
  - Light and durable for outdoor applications
  - Porous and degradable for agricultures
  - and many more…
- Textiles can be made from various materials
  - Cotton and wool
  - Polyester, polyamide or other plastics
  - Carbon, glass or metal

Textiles can be made in various structures, designed for individual purposes



Woven fabrics

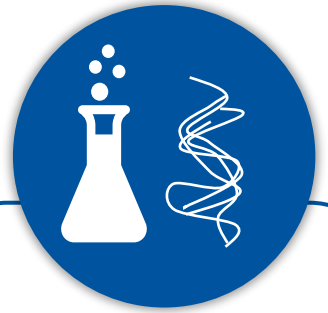
Knitted fabrics

Braided fabrics

Nonwovens

Non crimp fabrics

Textile Value Chain

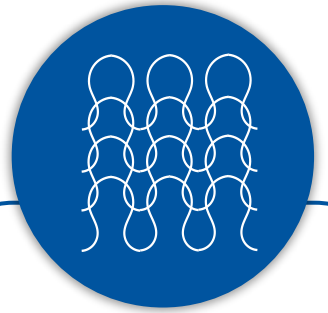


- Natural or man-made fibers
- New Materials

Raw Materials

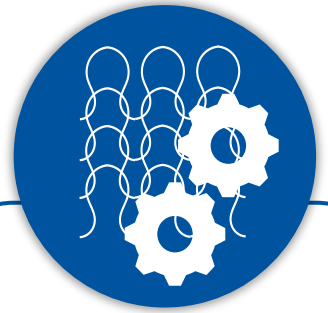
- Fiber Spinning
- Yarn processing

Yarn production



- Knitting
- Weaving
- Braiding
- Nonwovens

Fabric production



- Confection
- Sewing
- Finishing (Washing, Thermosetting)

Manufacturing

- Logistics
- Distribution
- Marketing

Final product

Challenges in developing textiles

- Find the right **yarn properties** for fabric production
- Develop new materials, which are **processable in melt spinning and knitting**
- Create fabrics which are **biobased** and **recyclable**
- Reduce the overall **carbon footprint** in the textile industry

Facilities at ITA

Test Laboratory:
Mechanical Tests
Textile Testing
Microscopy

Service Staff:
Mechanical Service
Electrical Service
Construction

Knitting:
Large Circular Knitting
Small Circular Knitting
Flat Knitting
Warp Knitting

Composite production:
Multi Layer Systems
Preforming
Processing

Nonwovens:
Carding Systems
Carbon Nonwovens

Braiding:
Radial Braiding
Circular Braiding

Tribological Laboratory:
Knitting Test Rig
Yarn Testing

Weaving:
Jacquard Weaving
Air Jet Weaving
Rapier Weaving
Shuttle Weaving
Ribbon Weaving
Sample loom

Carbon Processing:
Carbonization Plant
Carbon Fibre Processing
Composite Production

Spinning Plant
Bi-Component Spinning
Small Batch Tests
Polymer Laboratory

Medical Department:
Knitting
Braiding
Embroidery

Spinning Tower
Melt spinning
Polymer Yarns
Glass Fibres

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Textile development in AlgaeTex at ITA

Spinning and Texturizing

Aim:

- Spinning and texturizing benchmark materials (petrol based) to determine necessary process parameters for melt spinning

Approach:

- Spinning algae-based polymers on lab scale
  - Trials for different polymers and processes
- Texturize algae yarns

Knitting

Aim:

- Set up knitting process with benchmark yarn

Approach:

- Development of methods to investigate the knittability of new bio-based yarns

Development of Demonstrators at adidas

- Validation of industrial knitting processes
- Production of high quality demonstrators

- Establishing a comprehensive Life Cycle Analysis including all production steps
  - Enable partners to collect necessary data
  - Gather all data from all process steps
  - Analyse and summarize all data

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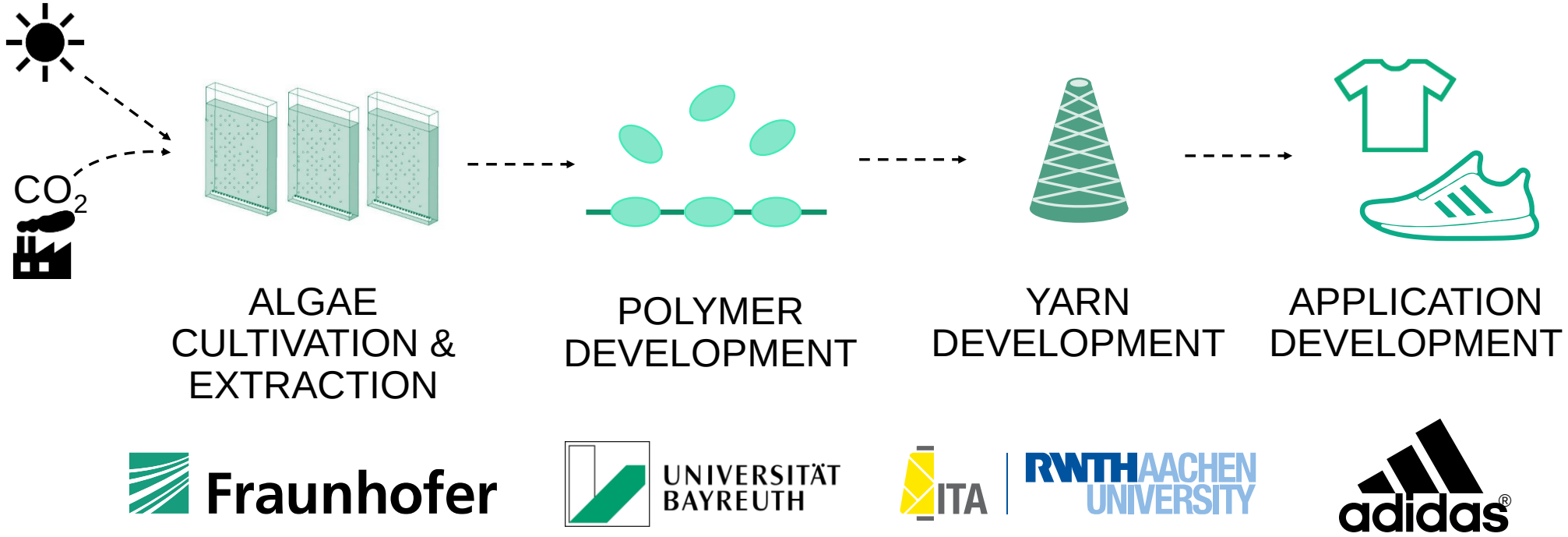

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Wissenschaftsjahr 2020|21
BIOÖKONOMIE

Textile Innovations
Sustainable.Digital.Individual.

Thank you
for your attention!