4D Textiles – morphing hybrid structures by additive manufacturing

David Schmelzeisen
3
Fiber based solutions 4 you
INTERDISCIPLINARY
INTEGRATED
INDUSTRY-ORIENTED
INTERNATIONAL
4 Divisions 400 Employees

Natural & synthetic fibrous material

Yarn  Fabric  Composite

(Semi-) Finished parts

RESEARCH AND SERVICE IN ONE HAND
Fiber based solutions for you

Health

Material

Mobility

Energy & environment

Knowledge-Transfer

Production

Information & communication

Building & living

AMEME

ITAAugsburg

ITATR

apoGMbH

TFImV.(GmbH)
RWTH Aachen Campus

RWTH Campus: a new kind of cooperation between industry and university

• Biggest technology campus in Europe
• Establishment of high-tech companies in 15 different clusters
• Exchange of research results, staff, other resources
• approx. 4 billion € investments until 2020
• approx. 10,000 jobs in research & development
Institut für Textiltechnik Aachen

International Locations

Geleen/NL  Istanbul/TR

Suwon/Korea  Augsburg/Ger
4D Textiles
4D Textiles – Vision
What are 4D Textiles?

The term „3D Textiles“ has been defined by Wulfhorst et al. in 2000.

4D Textiles are fabrics and textile products being able to change shape and function over time. This change is achieved by the complex interaction between hybrid materials and by the use of external stimulus.

Additional to the spatial expansion of fabrics (3D) the change over time faces the 4th dimension in textiles.
4D Textiles
4D Textiles – Methods

Simulation → Trials/Validation → Design/CAD → Product
4D Textiles – Simulation
4D Textiles – Trials/Validation
4D Textiles – CAD/Design

CAD

Design

38cm x 38cm x 1.25cm
4D Textiles – Applications

Health

ICT

Building

Mobility
Health

Approach
- Smart active biocompatible yarn materials
- Digital individualized braiding of yarn material
- Tissue engineering on 4D textile structures

Today
- Handcrafted stents
- Mechanical assembly
- Self expandable structures

Tomorrow
- Self assembled stents
- Individual self evolving structures
- Intelligent blood pump
4D Textiles – Applications

**Today**
- Static robot systems
- Predefined work situations
- No active interaction with the environment

**Tomorrow**
- Artificial intelligence
- Autonomous machines
- Self evolving structures
- Self assembly of robots

**Approach**
- Bionic muscle structures
- Active human-machine interaction by self learning textile
- Structural integrated motion control
4D Textiles – Applications

Today
- Glass fronts
- Light transmitting concrete
- Lightweight textile concrete

Tomorrow
- Bionic in- & outdoor components
- Interactive façade
- Intelligent response to outdoor conditions
- Self building elements

Approach
- 4D warp knitted structures
- Elastic concrete for outdoor applications
- Bionic design rules
4D Textiles – Applications

Today
- Lightweight bodywork
- Carbon fiber reinforced structures
- Passive aerodynamic
- Line-shaped design

Tomorrow
- Self expanding bodywork
- No structural parts needed
- Intelligent safety by shape change
- Active aerodynamic

Approach
- Hyper-elastic textiles functionalized by 4D printing
- Sensor systems for self evolving structures
- Design rules for 4D textile elements
4D Textiles - Book

Coming up: Summer 2017

4D Textiles
Vivid textile structures

Materials, Manufacturing & Design

Thomas Gries (Hrsg.)
4D Textiles - Conference

1st 4D Textiles Conference in June 2017
Digital Products – Dream2Lab2Fab
Textile Learning Factory „Digital Products and Production“

Product

Smart, customizable wristband

Machines

1. Warping creel
2. Warping machine
3. Weaving machine
4. Light table
5. Coating & thermo-setting device
6. Inkjet printer
7. Cutting machine
8. Sewing machine
9. Testing station
i4
The Institute
4D
Future Textiles
Thank you for your attention