

Pultrusion Conference 2021

Smart Roller Ski – Functionalized Radius Pultrusion in Application

Carsten Lies, Head of Department Lightweight Design

Fraunhofer Institute for Machine Tools and Forming Technology IWU

Profile of Fraunhofer IWU

Focus “Resource-Efficient Production”

- **Founded July 1st 1991**
- **Currently approx. 650 employees**
- **Approx. € 40 million annual budget**
- **Locations: Chemnitz, Dresden, Zittau, Wolfsburg, Leipzig**
- **3 scientific fields:**



Functional Integration and
System Integration



Production Systems and
Factory Automation



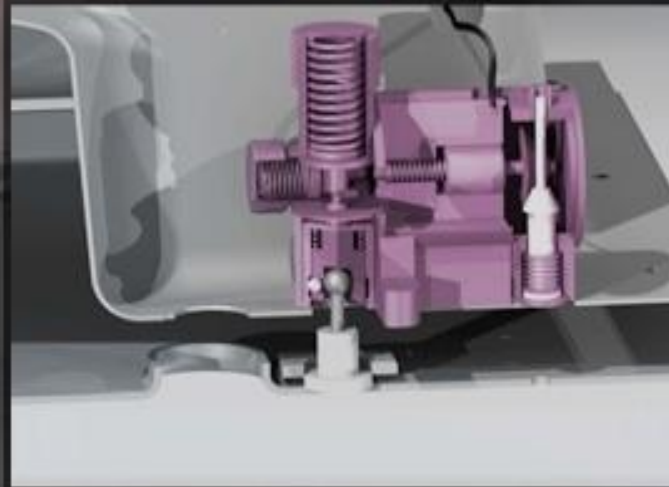
Process Technology

- **Fraunhofer-Gesellschaft: 74 institutes and research institutions at locations all over Germany**

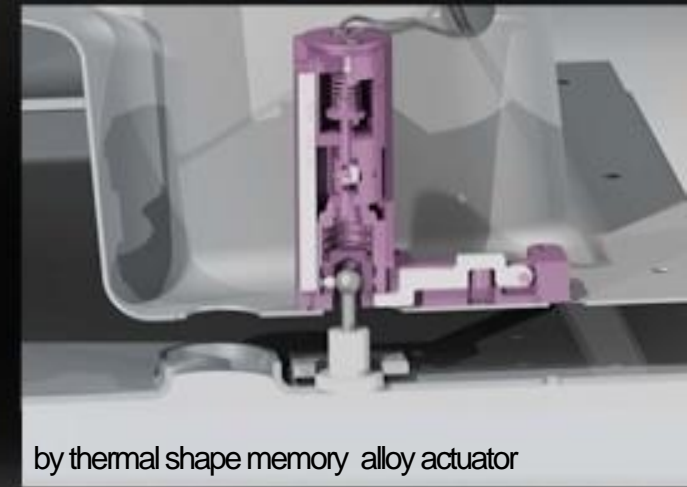
smart³ |
materials – solutions – growth

Paradigm change in product
conception

Function divided from the structure



Space und weight reduction



by thermal shape memory alloy actuator



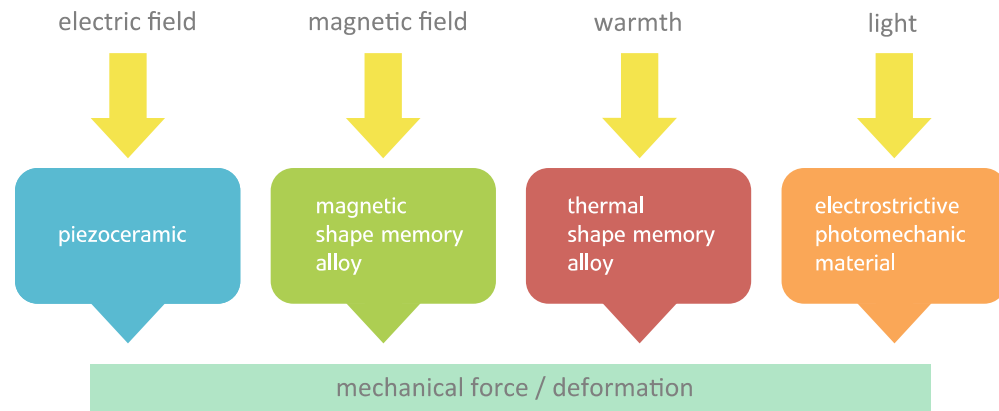
Vision: Fusion of function and structure

smart³ |
materials – solutions – growth

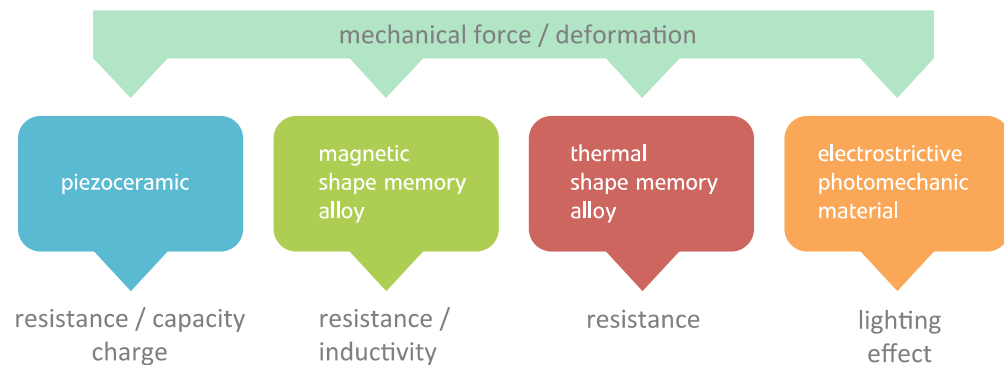
Development of market-ready intelligent materials and components in the categories mobility, health, energy and safety

Smart Materials an Overview

1. actuator mode

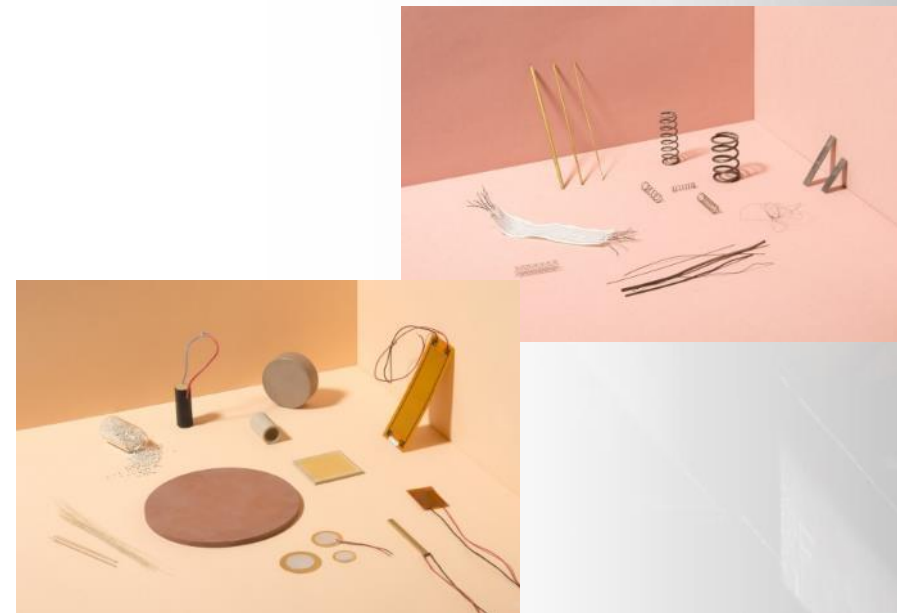


2. sensor mode



“70 % of all technological innovations in Germany are based on new materials.”

Institute for Trend and Future Research,
Heidelberg, Germany





Smart Roller Ski

Functionalized Radius Pultrusion in Application

- ✓ Fiber reinforced plastics (FRP) allows a completely new design
- ✓ Innovative radius pultrusion process
- ✓ Integration of sensors



Smart Roller Ski

Starting Position

- Conventional roller skis are made of simple straight aluminum square profiles:
 - No typical ski feeling due to the stiffness
 - No resilience, no springy effect
 - Restricted freedom of design



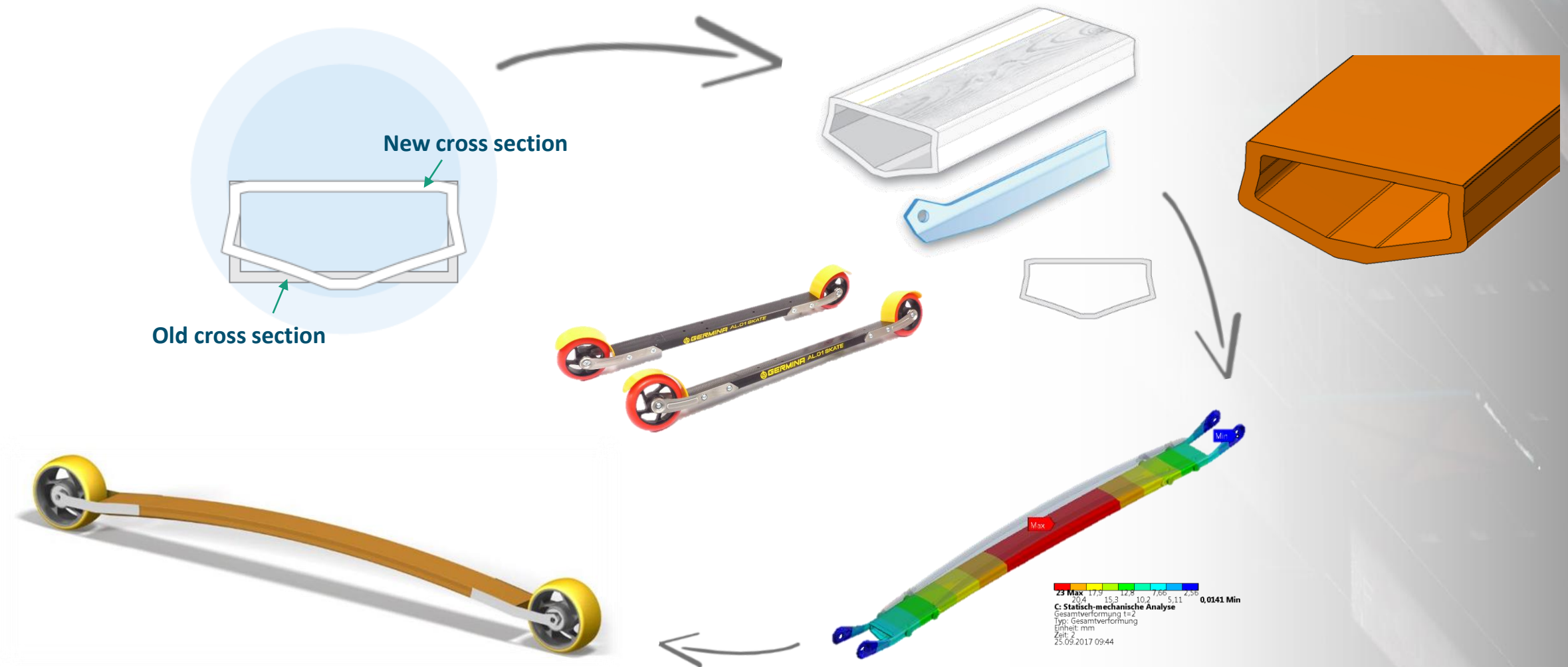
Smart Roller Ski

Method overview

- Redesign of a roller ski with **complex shaped profile**
- Usage of computer-aided simulations → calculation of a **load-compatible structure made of glass and carbon fiber**
- Hybrid structure allows the **absorption of all forces** and **reduces the mass significantly**
- **Integrated Piezo-MFC-Sensors** provide user feedback
- Enables a springy effect of the whole structure

Smart Roller Ski

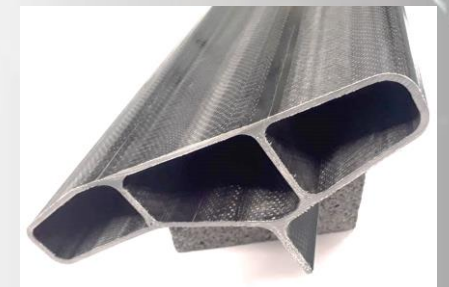
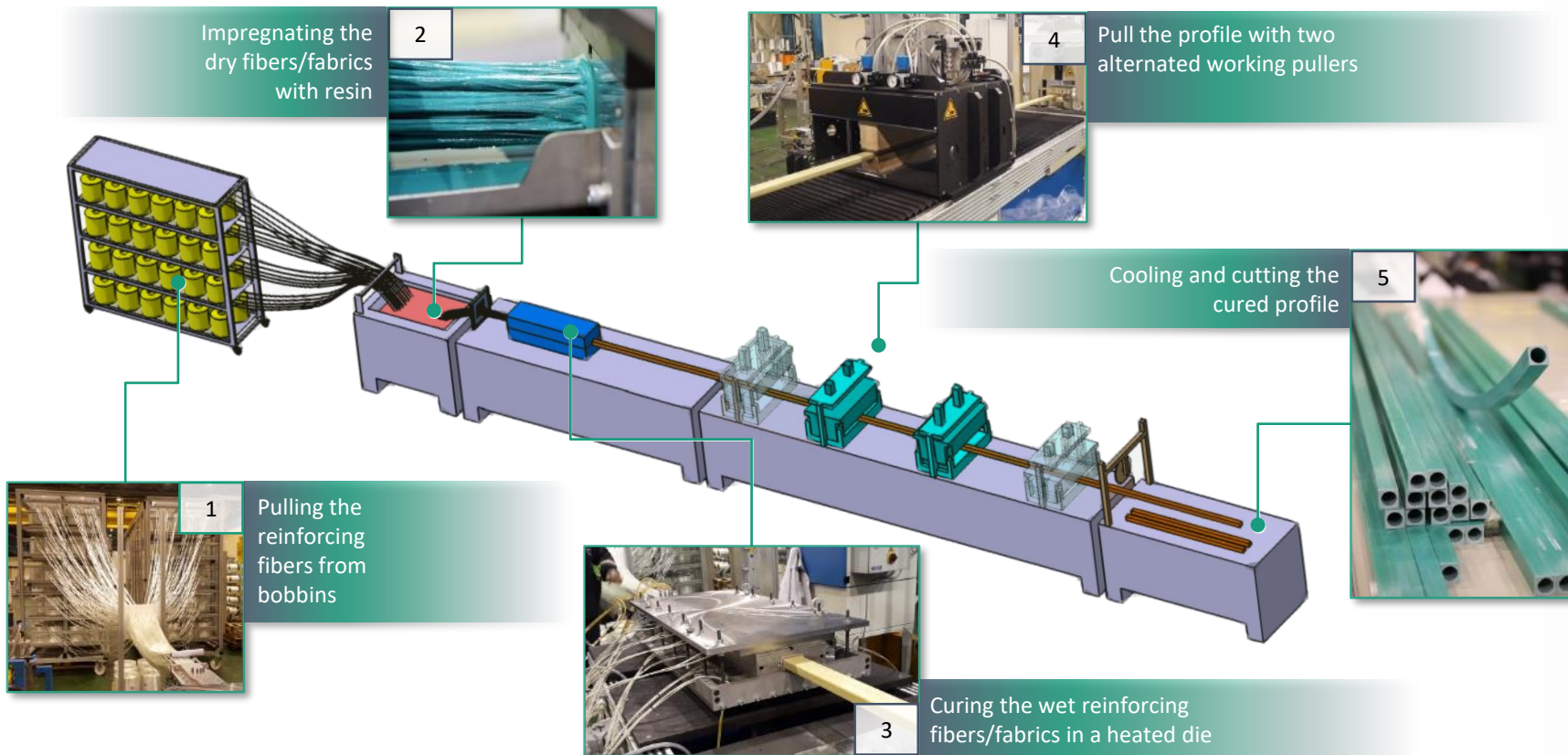
Method overview



Smart Roller Ski

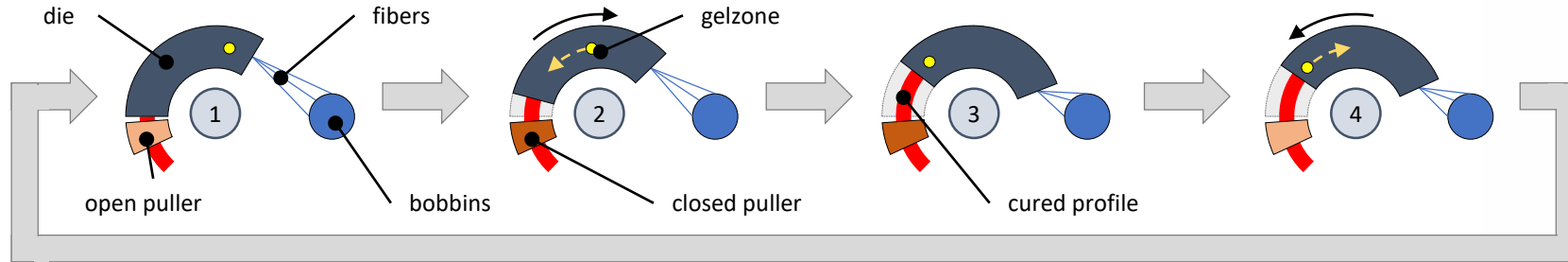
Pultrusion process

Pultrusion: Continuous and efficient process for the production of straight and low weight FRP profiles



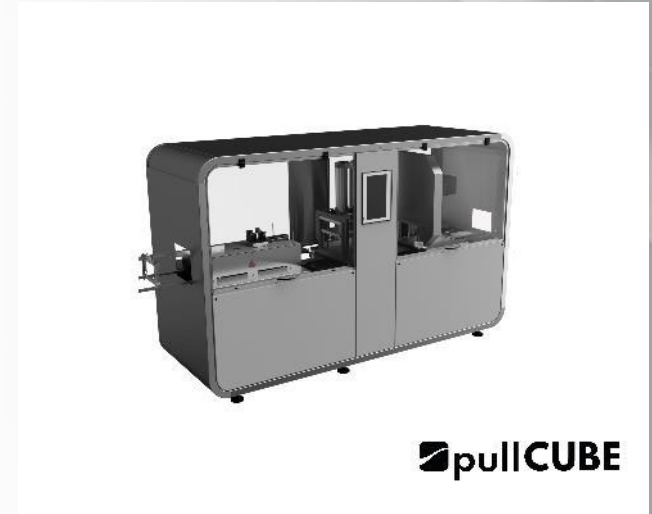
Smart Roller Ski

Pultrusion of curved profiles



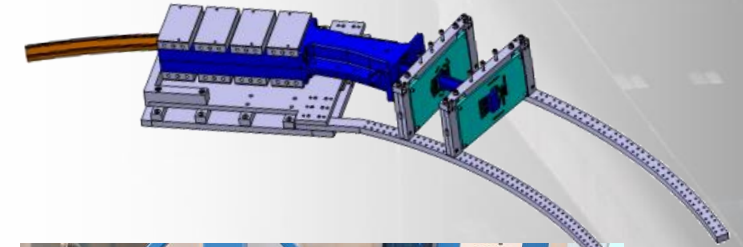
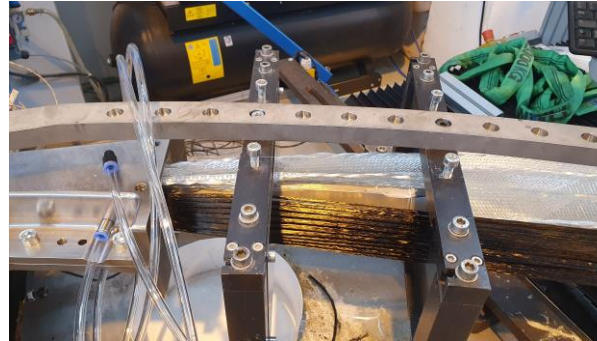
Modified pultrusion steps:

- 1 **Start position**
- 2 **Close the puller and move the die over the wet reinforcing fibers**
 - Gelzone moves in the opposite direction near to the end of the die
 - The cured profile leaves the end of the die
- 3 **End position**
- 4 **Open the puller and move the die back to the start position**

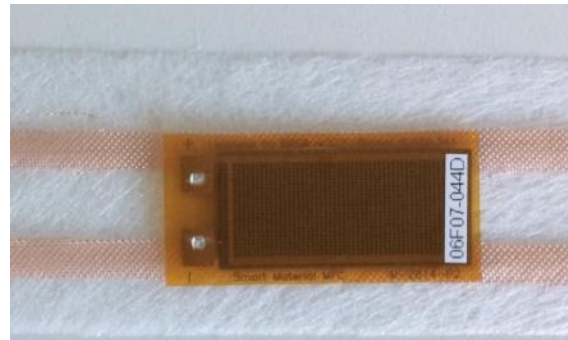
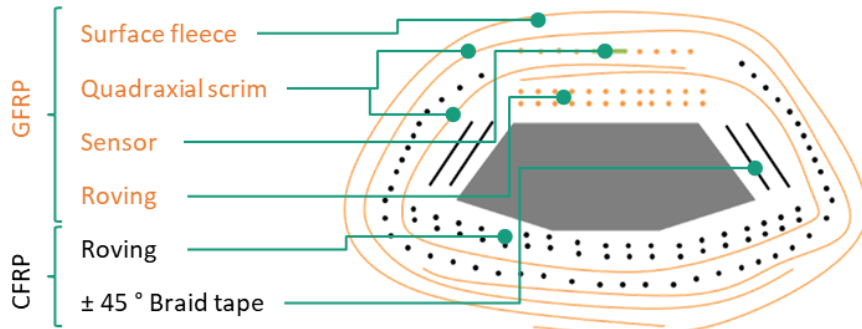


Smart Roller Ski

Sensor and actuator integration



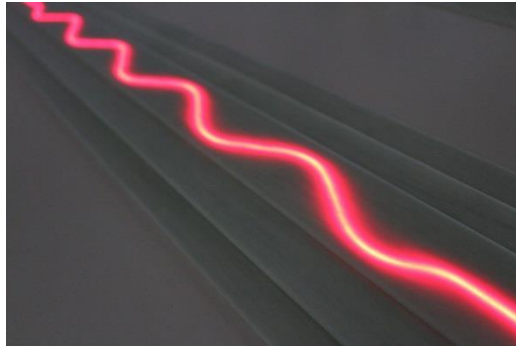
- ✓ Usage of rovings, multiaxial fabrics and a thermoset matrix
- ✓ Combination of cost-efficient glass fibers and high-performance carbon fibers



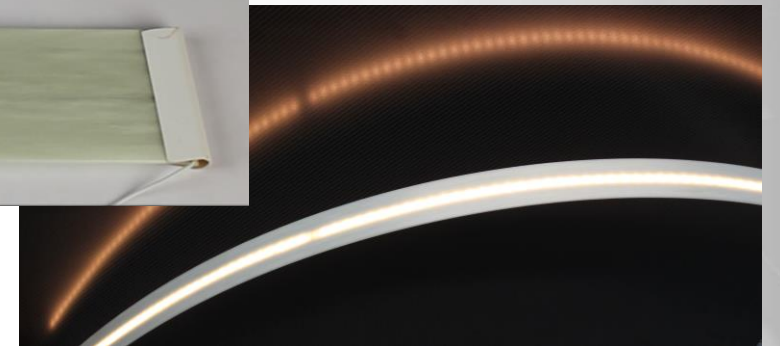
- ✓ Carrier tape made of non-woven glass fiber + MFC Type P2
- ✓ Contacting via copper-mesh stripes or copper-coated fleece

Smart Roller Ski

Further options for functionally integration



- ✓ functional integration of:
- Shape memory alloys
 - optical fibers
 - Led stripes

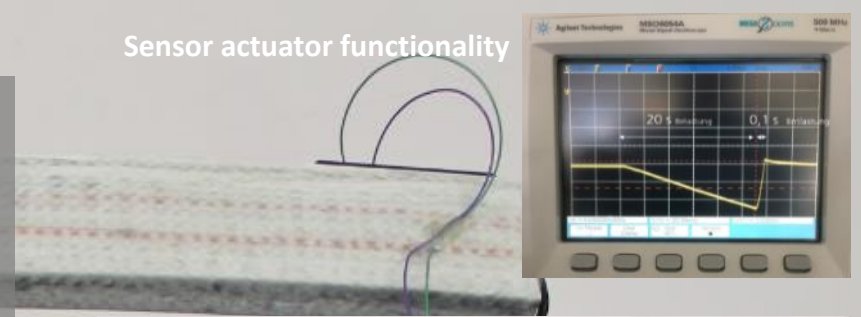


Smart Roller Ski

Results and discussion

- ✓ Special feature: **integrated piezo sensor**
- ✓ The **sensor gives the (hobby-)athlete a feedback**
- ✓ The analysis of occurring loads is possible and thus the optimization of the training
- ✓ The information of the sensors can be read out and evaluated wirelessly by a mobile phone app
- ✓ Complete training profiles can be created, recorded and analyzed subsequently
- ✓ The roller ski provides **increased ground clearance** and gives the user a **much more realistic ski feeling**
- ✓ In comparison to the aluminum profile a **weight reduction of about 20 %** could be achieved

Sensor actuator functionality



Thanks for your attention!

Carsten Lies

Dipl.-Ing.

Head of Department Lightweight Design

Fraunhofer Institute for Machine Tools and Forming Technology IWU
Reichenhainer Strasse 88
09126 Chemnitz, Germany

Phone: +49 371 5397-1941

E-Fax: +49 371 5397-1796

Carsten.Lies@iwu.fraunhofer.de

<http://www.iwu.fraunhofer.de/pultrusion>

<https://www.iwu.fraunhofer.de/en/research/range-of-services/Competence-from-A-to-Z/lightweight-construction.html>



Title

- Content

Section

Subhead

Title

- Content

- Content



