Integrative Approach for Production Technology for Multi-Material Lightweight Components

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Structure

- **AZL Approach**
  Connecting Research and Industry For Lightweight Production

- **AZL Partner Network and Open Innovation**
  Enabler for the Development of Multi-Material Production Technology

- **Project Example: “OptoLIGHT”**
  Production of Multi-Material Thermoset-Thermoplastic FRP Parts in one integrated Process Chain
Inspire your employees and customers at one of Europe’s leading Technical University

RWTH Aachen
- Founded in 1870
- 260 research institutes
- 538 professorships
- 5,355 scientists
- 44,517 students
- 2 clusters of excellence:
  - “Integrative Production Technology for High-Wage Countries”
  - “Tailor-Made Fuels from Biomass”

New RWTH Aachen Campus
- 2 areas with 800,000 m²
- Emphasis on production technology:
  - 62 professorships
  - 12,050 students, 2,600 employees
- Already signed industrial collaborations:
  - 120 international and national companies
  - 30 research institutions
Introduction

Composite Competences along the Value Chain

Composite competences and cooperation since more than 25 years

- Textiles (ITA)
- Plastics and Composites (IKV)
- Production Technology (AZL, WZL, IPT, ILT, ISF)
- Quality Assurance (WZL)
- Lightweight Design (IKV, SLA)
- Automotive (ika)
- 9 Institutes
- More than 750 scientists
- More than 1,100 student workers

1987 - 2016

AZL Aachen GmbH – Excellence in Lightweight Production
AZL – One-Stop-Shop for Lightweight Production
Innovation Strategy of AZL
Composite Competences along the Value Chain

Using the Aachen Competences along the Value Chain

Lightweight Materials & Design
- Raw Materials
- Semi-finished Materials
- Composite/ Multimaterial Systems
- Product Design

Production Technology
- Manufacturing Technologies
- Production Machines/ Tools
- Quality Assurance
- Production-/ Cost Planning

= Integrative Approach

Research on Interdependencies:

Materials
Processes
Machines
Product Design

Innovations

Integrated Parts based on Multimaterial Systems

Innovations

Integrated „Intelligent“ Process Chains

Innovations

Hybrid Production Machines
Innovation Strategy of AZL
Composite Competences along the Value Chain

Technology-Push

Market-Pull

Demands from the Industry

Innovations lead to:

- Efficient material usage
- Efficient processes
- Efficient production systems
- Increased performance-cost-ratio

Benefits:

- Short cycle times
- High quality
- Reproducibility
- Cost efficiency
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AZL Aachen Partner Network:
More than 80 Partner Companies from 21 Countries
AZL Aachen Partner Network: More than 80 Partner Companies from 21 Countries
AZL Partnership

Benefits

- Joint Business Development
- Cost-Sharing in R&D
- Open Innovation & Networking
- High-Potential Graduates
- Shared Offices
AZL Partnership

Services

Annual Partner Meeting
Workshops & Workgroups
Joint Partner Projects
Acquisition of Public Funding
Networking

Marketing, PR
Human Resources
Extended Matchmaking
Market Intelligence
Shared Office
Annual Partner Meeting – Impressions
3rd AZL Annual Partner Meeting – June 2016

150 Participants
65 Companies
9 Institutes
6 Project Proposals
26 Presentations
2 Days
Annual Partner Meeting 2016 – Impressions
Update and Definition of AZL Activities
Previous AZL Workshops

- Joining
- Low-Cost and Energy-Efficient Double-Belt Presses
- Thermoplastic Tapes
- Research Landscape for Composites – Germany and EU
- Process Costing Tool
- Quality Assurance in Composite Value Chains
- Printed Lightweight Structures
- Design and Process Systematics
- End-machining of Fiber-Reinforced Plastics
Workshops and Workgroups
Meetings in Workgroups and Project Consortia 2016

9 Workgroup Meetings & more than 20 Project Meetings

About 600 industrial Participants in total

Workgroup on High-Performance SMC initiated

3 Kick-Offs of Joint Partner Projects and Studies
Workshops and Workgroups
Upcoming Meetings for AZL Partners

- First Report Meeting B&I Study 22 Mar
- Web Conference Business Cases 1-3 11 May
- AZL Open Day 2017 Lightweight In Aachen 25 Apr
- 3rd Workgroup Meeting High-Performance SMC 31 May
- 4th Workgroup Meeting Pipes and Vessels 30 May
- AZL Annual Partner Meeting 2017 21 & 22 Jun
- 5th Workgroup Meeting High-Speed RTM Matrixes 26 Sep
- 4th Workgroup Meeting High-Performance SMC 15 Nov
- 5th Workgroup Meeting Hybrid Thermoplastic Composites 10 Oct
- IAA 14-15 Sep B2B Networking Event at IAA Frankfurt
  Keynote Presentations | Networking Dinner | Guided Visits at the 67th International Motor Show
- kompozyt-expo 12-13 Oct Joint Business Development Trip to Poland
  B2B Meetings at Kompozyt Expo 2017
  Guided visits to Polish composite companies
Joint Partner Projects

Joint Partner Projects derived from Workshops

New Designs for Low-Cost and Energy-Efficient Double-Belt Presses for Continuous Composite Manufacturing

- 8 AZL partner companies involved
- Start: November 2014
- Duration: 1 year
- Pre-competitive research project

Composite sheet production can be divided into three relevant stages:

- Injection
- Solidification
- Pre-curing

Output
- Semi-finished products
  - Tubing
  - Composite sheets
  - Sandwich panels
  - Near-finished products
- Trailer rails
- Container walls

State of the art
Process steps & physical principles
Joint Partner Projects

Joint Partner Projects derived from Workshops

Thermoplastic Tapes – Material and Processing Benchmark

- 7 AZL partner companies involved
- Start: November 2014
- Duration: 1 year
- Pre-competitive research project
Joint Partner Projects
Joint Partner Projects derived from Workshops

Concept, Design and Buildup of a Prototype for the Ultra-Fast Manufacturing of Tailored Composite Blanks

- 12 AZL partner companies planned
- Start: Beginning 2016
- Duration: 18 month
- Pre-competitive research project

Project consist of 4 Phases

Phase 1  State of the Art
Phase 2  Concept Phase
Phase 3  Proof-of-Concept
Phase 4  Process and Feasibility
Joint Partner Projects
AZL Market and Technology Study (2013 - 2014)

- Identified **450 attractive components**
- **Technology analyses** of **50 highlight components** incl. market size and development, technological maturity, competitors etc.
- **12 detailed business cases** including comprehensive profitability, technology analyses and concept development for new profitable production chains

- **Start of project:** March 2013, duration: 12 months
- **International industrial consortium** with 33 companies
  - 14 Material Suppliers, 6 OEM, 7 Tier 1/2, 6 Equipment Provider

**Final Study Results (2014)**

- **Demonstrator Business Cases**
  - e.g. Pipes & Vessels
- **Cross-sectional Topics:**
  - e.g. Efficient Double Belt Presses
  - e.g. Tape Qualification
- **AZL Partnership Project**
  - Workshop Topics
  - Workgroup Topics
  - Joint Partner Projects
Joint Partner Projects
Final Call: Composites in Buildings & Infrastructure

Outcome:
- 100 Applications
- 25 Detailed Component Analyses
- 10 Highlight Business Cases

Conditions:
- Kick-Off November 21st, 2016
- 6 Months
- More than 25 Study Partners

Joint Market and Technology Study
New Potentials for Composite Technologies in Buildings and Infrastructure

More than 25 Study Partners already involved
Kick-Off Meeting
Market and Technology Study “Buildings and Infrastructure“

AZL Partner Companies

External Companies
Joint Partner Projects
Impressions Kick-Off “Buildings & Infrastructure“
Extended Matchmaking
Market Focus: Networking event at IAA

September 14th and 15th, 2017
Frankfurt/Main, Germany

Our Program Proposal:

Part One: September 14th | Afternoon
Keynote presentations of key players of automotive industry and lightweight trend discussion

Part Two: September 14th | Evening
Networking dinner with rotating table groups per course

Part Three: September 15th | Morning
Guided tours to lightweight company booths
Extended Matchmaking
Region Focus: Guided visits to Polish composite industry

Day One: October 12th
B2B Meetings at KOMPOZYT EXPO 2017

Program
- Guided tours to company booths
- Option for individual B2B meetings
- Networking Dinner

Source: https://issuu.com/targikrakow/docs/brochure_kompozyt-expo_2016/5?e=8714510/33639766
Extended Matchmaking
Region Focus: Guided visits to Polish composite industry

Day Two: October 13th
Focus visit to one economic zone

Polish Special Economic Zones (SEZ)

Exemplary: WSEZ Breslau (Wrocław)

- One of the biggest and fastest developing zones in Poland


Polish Special Economic Zones (SEZ)
Market Intelligence
Market Reports for Market Intelligence

- Regular analysis of free available market reports
- Highlighting of key facts and market trends in an executive summary for each report
- Analysis by market, region and process

More examples: Market insights from Composites World and JEC magazine or ACMA
Market Intelligence
Conference Analysis for Market Intelligence

- Listing and evaluation of European lightweight conferences
- Aim: Targeted participation in conference
- Evaluation according to following criteria:
  ✓ Addressed markets
  ✓ Addressed technologies
  ✓ Audience
  ✓ Networking options
  ✓ Business Development options
- January 2017: Conference Report for 2017,
  End of 2017: Report for 2018
9 Business Cases for Market Intelligence

- **9 Business cases** of selected lightweight components
- Detailed cost benefit analysis of lightweight applications
- **3 workshops** as web conferences:
  - Detailed review of 3 business cases each
  - Selection of future business cases
- Cost Analysis realized by »OPLYYSIS« – Process Chain Costing Tool
Shared Office
Working Shoulder to Shoulder at AZL Center

- Be present at one of Europe´s largest technology research campus (473,000 sqm)
- Use an **inspiring environment** for your employees, customers and business partners
- Meet your business partners on site
- Have **easy contact** to a network of research institutes and industry
- Be updated on new technologies
- **Cost-efficient** office space
Campus Project of RWTH – One of the largest European Research Landscapes

6 out of 16 new Clusters at Campus:

- Bio-Medical Engineering
- Production Engineering
- Heavy Duty Drives
- Photonics
- Smart Logistics
- Sustainable Energy
AZL Infrastructure News
Cluster Building “Integrative Production Technology”

Impressions of AZL’s new home

Source: AZL

Source: Capricorn Development, Henn Architekten
Campus Office

Co-Working Space at new AZL Center

AZL Offices

Communication Zone

Meeting rooms

Premium Partner Offices
(all-year exclusive usage)

Shared Office
Co-Working Space at new AZL Center

Our Proposal

Exclusive usage of one office for Premium Partners

- Fully equipped for two employees (min. 16 m²)
- All-year usage of one exclusive office
- Usage of meeting rooms
- Usage of communication zone

Shared office for Business Partners

- Fully equipped
- Office usage on 4 days a month
- Meeting rooms for 2 half-day meetings a month
- Usage of communication zone
Once a year, we have an Open Day!

- Guided tours to lightweight research institutes represented by AZL
- Overview on lightweight research in Aachen
- Update on RWTH Campus activities and opportunities
- Networking with Aachen research engineers and industry

Save the date
April 25, 2017

To be invited to the next Open Day, please write an e-mail to registration@azl-aachen-gmbh.de
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Project Example
BMBF-Project „OptoLIGHT“

„OptoLIGHT“

- Time Frame:
  - Start: February 2014
  - Duration: 3 years

- Project Objectives:
  - Laser sublimation for local exposing of fibers
  - Integrated laser structuring (preparation for joining)
  - Laser cutting and laser trimming
  - Optical process control
  - Optical control of part quality

- Project Partner:
  - AZL
  - BMW
  - KraussMaffei
  - Arges
  - Precitec
  - Steinbichler
  - Sensotherm

Combination:
Thermoforming – Injection Molding – Laser Processing
Motivation

Connecting Worlds of Materials

High strength and stiffness in combination with low creep tendency
Part performance
Higher freedom of design and functionalization
Low production cost
High degree of manufacturing integration at low cycle times

- Use of **design stiffness** and **material stiffness** required
- Improvement of **component performance** and **functional integration** by purposeful combination of materials
Motivation
Approach for Adhesive-Free Material Joining

1 RTM-component
2 Matrix sublimation
3 Hybrid-component

The exposure of the fiber structure is defined as a (photonic) pre-treatment process for a variety of joining processes caused by thin-film sublimation of the matrix material without damaging the underlying fibers. → Intrinsic joining without using adhesives by fiber wetting based on micro form-fit
Compact laser scanner with OCT sensor system for on-axis depth measurement

Averaged temperature of the laser spot surrounding [°C]

Averaged removal depth [µm]

ns - short pulse laser
continuous wave (cw)

Fluence [J/cm²]

lower temperature measurement threshold

Averaged temperature of the laser spot surrounding [°C]

Source: Arges GmbH, Precitec GmbH & Co. KG, Sensortherm GmbH

10 March 2017

Source: Arges, AZL
Investigations on Process Interactions

Overmolding

Figures with exemplary correlations of laser and injection molding to shear strength:

- DEMAG 80t
- Mass temperature: 270°C
- Injection speed: 75 cm³/s
- Max. injection pressure: 900bar
- Holding pressure: 250 bar
- Mold temperature: 90 °C
- Lanxess Durethan BKV30 H2.0 901510
- Momentive EPIKOTE Resin 05475 with EPIKURE Curing Agent 05500

**Project Example**

**BMBF-Project „OptoLIGHT“**

**Use of material**
- Continuous fiber reinforced thermoset composites
- Long fiber reinforced thermoplastic composites

**RTM process**
- Near-Net-Shape-Preform
- RTM component
- Sublimation of resin (local exposing of fibers)
- RTM component

**LFT Injection molding**

**Cleaning, trimming and structuring for preparation of joining**

**Geometry and joining inspection**

**Quality characteristics:**
- Strength, stiffness, ease of installation, design, sustainability

**Partners:**
- BMW
- ARGES
- KraussMaffei
- SENSORtherm
- Steinbockler
- Precitec

**Structural component (BMW i3)**

Integration of composite and laser system technology in one manufacturing cell

AZL Aachen GmbH – Excellence in Lightweight Production
Project Example »OPTO-Light«
Integration in One Near-Series Production Cell

3d-Laser-Scanner

Embossing technology

Reaction technology

Tool technology

Injection molding

Robotic

Cell controller

Laser process sensors

Optical Q-Assurance

Project Example »OPTO-Light«
Installation of Near-Series Production Cell

KraussMaffei 200-380-180 CXW

- 2k-injection molding machine with rotating mold
- Backmolding of laser pre-treated thermoset CFRP
- Challenging mold technology for hot-pressing of prepreg laminates in vertical parting plane
Your Contact

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