

TECHNISCHE UNIVERSITÄT CHEMNITZ

CLUSTER OF EXCELLENCE MERGE

Merge Technologies for Multifunctional Lightweight Structures EXC 1075



FG Deutsche Forschungsgemeinschaft

כ











The last three decades at BMW





BMW 3er (E21, 1975 - 1983) with 1010 kg



BMW 3er (2009) with 1435 kg





The last three decades at Audi







Audi 80 B1 (1972 - 1978) with 830 kg



Foto: Hans-Dieter Seufert

Audi A4 (2009) with 1300 kg





Merge Technologies for Multifunctional Lightweight Structures







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Transition from manual to industrial manufacture









- **Weight reduction (up to 30 % compared to aluminum)**
- Decrease in the average cost of metal components
- Training of qualified personnel



Competitive edge in aircraft construction



Entry into mass markets (e.g. car manufacture)





ENERGY SAVING IN PRODUCTION



ENERGY SAVING IN USE





Focus

- Merging of key enabling technologies, which are already technically mature
- In-line and in-situ technologies predestined for large-scale production
 - > Metal-intensive technologies
 - Textile-/Plastic-based technologies
 - Micro- and Nanosystems Integration









In-line and In-situ Process Chains







Interacting Research Domains







IRD D: Micro- and Nanosystems Integration



Main objectives of IRD D

Micro- and nanosystems in hybrid structures by integration of:

- sensors, actuators
- , electronics
- > power supply
- communication interfaces







IRD D: Micro- and Nanosystems Integration







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Industry 4.0 - Aircraft Composites



Sources: Airbus, CTC





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Integration of Industry 4.0 in the future aircraft factory



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Vertical Integration - Smart Factories



Smart Factories

Decentralized production control, Data-Driven operational excellence

Introduce fully digital planning and data-driven execution



Interactive SOI









Sources: Airbus, ZAL





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Horizontal Integration - Smart Supply Network

Horizontal Integration

Virtual product available



Smart Supply Network Collaboration network, sophisticated marketplace

Collaboration network, sophisticated marketplace offerings, Fully connected supply chains and logistic

Visibly connect the entire production

network

- paperless supplier "network"
- real-time-inventory management
- 3D printed spares
- End-to-End data optimisation
- process harmonisation
- → "Design anywhere build anywhere"



Sources: Airbus, ZAL





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Full Integration - Digital End-to-End Engineering



Digital End-to-End Engineering Data and information available at all stages of a product lifecycle

Design and simulate the virtual product



Manufacturing Assembly Recycling Cost ...

Augmented Reality













Sources: Airbus, ZAL



www.tu-chemnitz.de/MERGE



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Regulated process by predictiv Controller as first step to Industry 4.0

controller



complex, product-individual assembly process



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Process simulation – Infusion process







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Process Monitoring

Degree of cure depends on:

- Temperature
- Time
- Resin System



A = point of gelation; B = point of vitrification, Phase I = liquid; Phase II = viscous,; Phase III = solid





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Fiber Optic Based Sensors

- Sensors
 - Plastic optical fibers

(Fabrication and characterization of Bragg gratings in perfluorinated polymer optical fibers and their embedding in composites (2016))

Glass optical fibers

(Signal evaluation of fibre optical sensors embedded between unidirectional thermoplastic prepreg tapes in a hot-press consolidation for online process monitoring (2015))

- Fiber Bragg Gratings
- Methods
 - Fresnel reflection
 - Fiber Bragg grating reflection
 - Optical frequency domain reflection (OFDR)
- Detections
 - Strain
 - Temperature
 - Flow front
 - State of cure







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7mm

Electric Sensors

- Sensors
 - Resistance strain gauges
 - Interdigitated electrodes

 (Design, fabrication and embedding of microscale interdigital sensors for real-time cure monitoring during composite manufacturing 2016)
 - Piezoresistive pressure sensor
- Methods
 - Direct current (DC)
 - Alternating current (AC)
 - Wireless
- Detections
 - Temperature
 - Strain
 - Flow front
 - State of cure
 - Moisture
 - Pressure







Contact us!



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