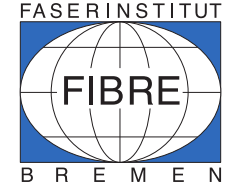




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Online Process Monitoring in Hybrid Injection Overmoulding

Michael Petrich

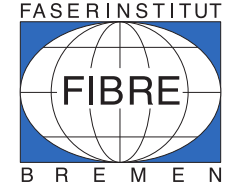
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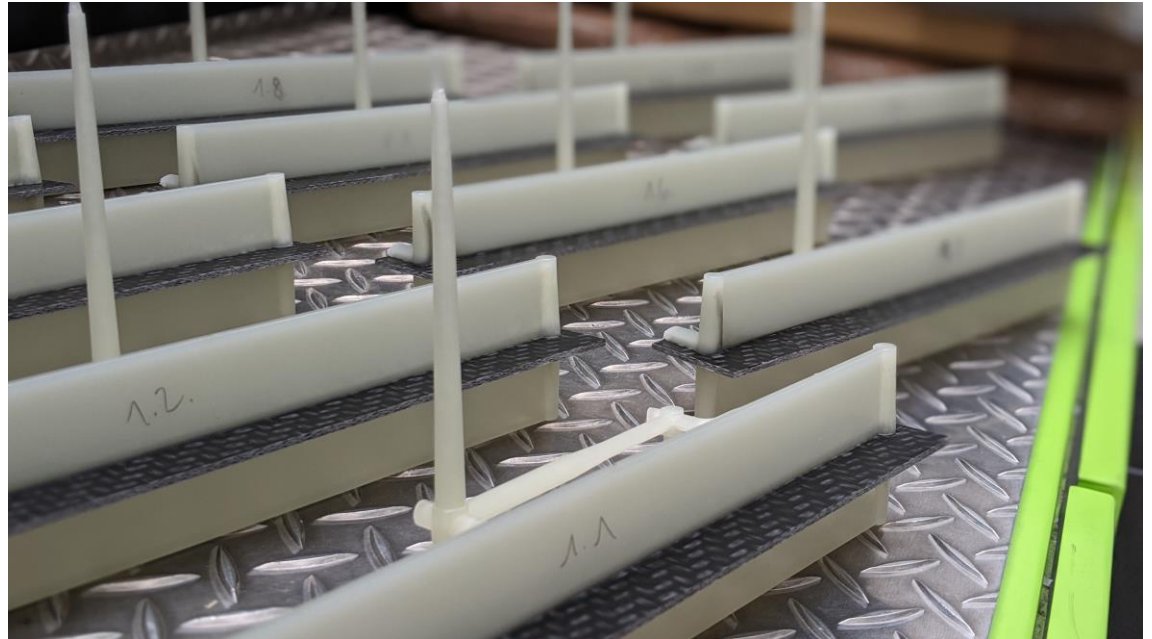
Hybrid Injection Overmoulding



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- Combines properties of organosheets and injection moulding:
 - Excellent mechanical properties
 - High degrees of geometric freedom
 - Short cycle times
- Strength of hybrid structures determined by the interface between insert and injection moulding compound
- Incomplete understanding of process and lack of quality insurance



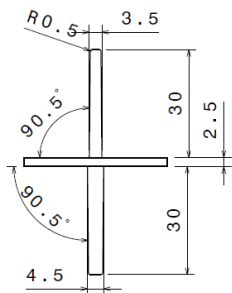
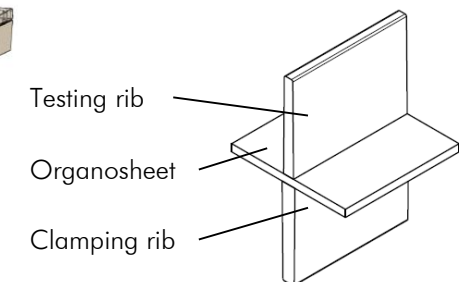
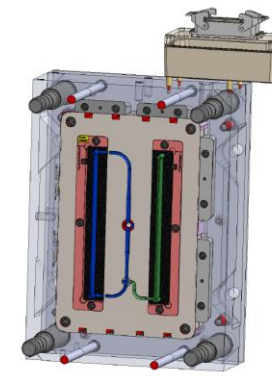
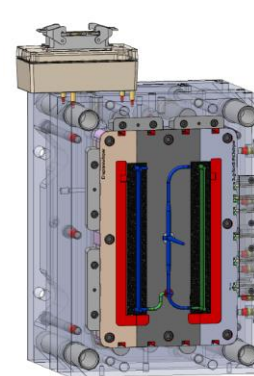
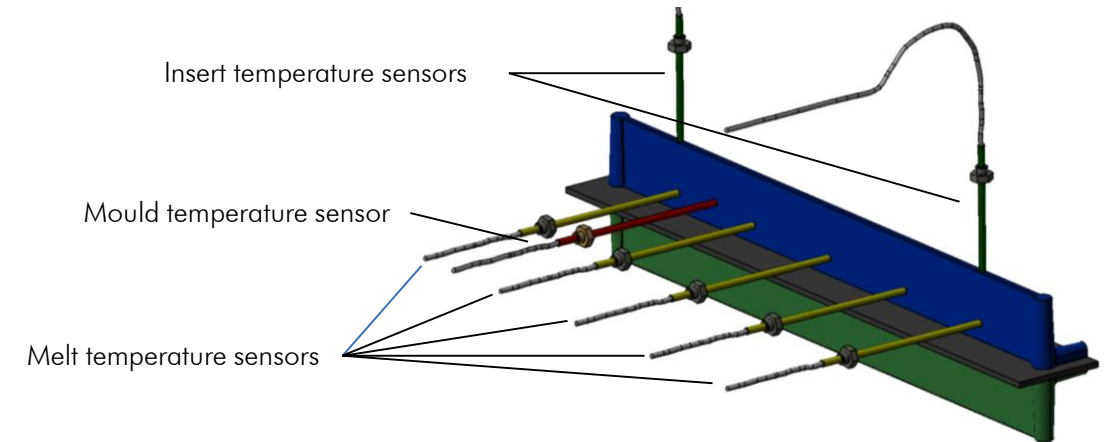
Online Process Monitoring



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- Overmoulding tool for interface bonding specimen
- Sensor system for in-situ process monitoring inside the tool
 - Insert temperature
 - Melt temperature
 - Mould temperature
 - Melt front speed
- Definition of a process window for complete bond formation



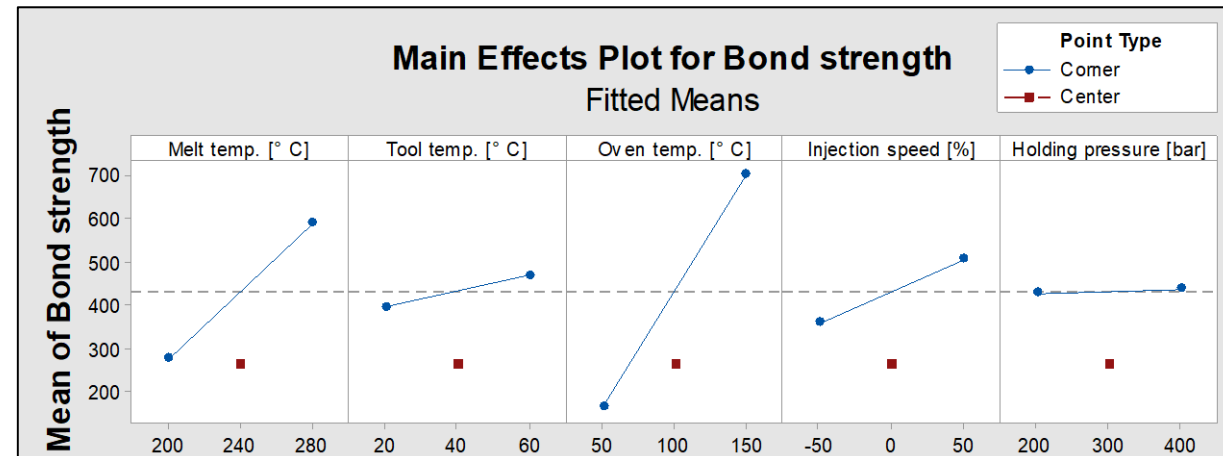
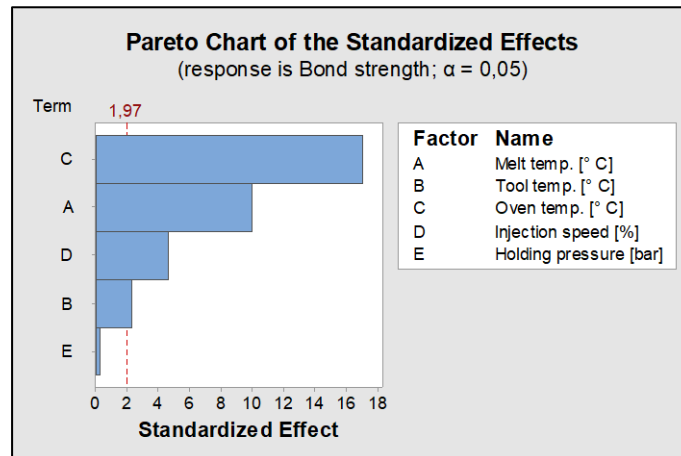
Results



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- Sensor system measures in-cavity temperatures online and throughout the injection process
- Study of the effects of various process parameters for PP-GF material system
- Interface bond strength most heavily influenced by:
 - Insert temperature
 - Melt temperature



ONLINE PROCESS MONITORING IN HYBRID INJECTION OVERMOULDING

Authors: Michael Petrich, M. Sc., Christoph Hoffmeister, Dipl.-Ing., Prof. Dr.-Ing. Axel S. Hermann

Motivation

- Hybrid injection overmoulding combines properties of organosheets and injection moulding
- Excellent mechanical properties
- High degree of geometric freedom and short cycle times
- Strength of hybrid structures is primarily determined by the interface between insert and injection moulding compound
- Use for safety-critical parts (e.g. aerospace primary structures) is hindered by incomplete understanding of the process and lack of quality assurance

Goals

- Tool development for fabrication of specimen and online process monitoring
- Measuring of decisive process variables inside the mould cavity via integrated sensors
- Evaluation of tool and sensor system through a statistical test plan
- Study effects of various machine and process parameters on measured in-cavity process variables and resulting properties
- Definition of a process window for the complete bond formation between insert and injection moulding compound as basis for quality assurance

Overmoulding Tool & Test Specimen

- Test specimen for the determination of bonding properties at the interface
- Organosheet insert overmoulded with short-fibre reinforced thermoplastic ribs
- Double rib geometry to prevent bending of organosheet in tensile test
- Variable tool design allows variable insert thickness, injection sequence, distance from gate and creation of weld lines
- Wide range of processible materials up to high temperature thermoplastics such as PEEK

Sensor System

- Three different types and a total of eight sensors included in the tool
- Measurement of insert, mould and melt temperatures throughout the injection process
- Placement of sensors allows determination of melt flow rate in the cavity
- All sensors were provided by project partner FOCi Messtechnik GmbH within the scope of the research project QuaSimOdo (Quality assurance in the overmoulding process - online)

Experimental Procedure

- Statistical test plan (DoD 2-plan with centre point, 170 points, 550 tensile specimens) to determine effects of process and machine parameters
- Material system
 - Insert: PPH-GF organosheet; 2.6 mm; Bondmaster Thermath dynalene
 - Injection moulding compound: PPH-GF, short fibre reinforced; Borealis G825U
- Effects on in-cavity temperature, flow rate and bonding strength investigated
- Investigated process parameters:
 - Melt temperature
 - Tool temperature
 - Oven temperature
 - Injection speed
 - Holding pressure

Process parameters	Lower level	Default level	Upper level
Melt Temp. (°C)	280	300	320
Tool Temp. (°C)	20	40	60
Oven Temp. (°C)	80	100	120
Injection speed	10 %	Revised	50 %
Holding pressure	100	200	400

Results

- Independently significant effects investigated:
 - for in-cavity temperature: Melt temperature
 - for flow rate: injection speed, melt temperature
 - for interfacial bond strength: Oven temperature, melt temperature, injection speed, tool temperature
- The bond strength as a main quality criteria is most heavily influenced by melt and oven temperature, resulting in a higher interfacial temperature

Conclusion

- The developed test specimen is capable of indicating the effects of various process parameters on interfacial bond strength
- The integrated sensor system measures in-cavity temperatures of melt, insert and mould online and throughout the injection process
- Melt temperature and preheating of the insert have been identified as the most influential factors for high interface strength
- The developed process monitoring system will be transferred to high temperature thermoplastic materials within the scope of the HiQO (High Quality Overmoulding) research project
- For process validation a generic sensor component will be manufactured
- Online measured process variables and quality assessment are stored in a electronic component file

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Faserinstitut Bremen e.V.
Michael Petrich, M.Sc.
Am Biologischen Garten 2
28359 Bremen (Germany)

Phone: +49 (0) 421 218 5855
Fax: +49 (0) 421 218 5870
Email: petrich@faserinstitut.de
Web: www.faserinstitut.de

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Thank you for your attention!

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