

# Table of Contents

## Preface

## Chapter 1: Polymer Matrix Composites (PMC)

<b>Evaluation of DOPO and Nano-Silica Modified Epoxy Resin Systems as Low Viscous, Flame Retardant Additives for Infusion and Injection Processing of Carbon Fiber Reinforced Plastics</b>	
M. Häublein, K. Peter, A. Brückner and V. Altstädt	3
<b>Comparison of Low-Velocity Impact Damage Behavior of Unidirectional Carbon Fiber-Reinforced Thermoset and Thermoplastic Composites</b>	
F. Schimmer, S. Ladewig, N. Motsch, J.M. Hausmann and I. Ehrlich	9
<b>New Silicone-Resin-Compounds for Casting and Molding Applications</b>	
J. Lambrecht and M. Winterer	15
<b>Fatigue Behaviour of Triaxial Braided Composites under Tension-Tension and Compression-Compression Loading</b>	
F. Herrla and H. Rapp	23
<b>Investigation on the Crack Evolution in Glass-Fiber Laminates Depending on the Stacking Sequence</b>	
B. Begemann and P. Horst	29
<b>Development of a Modular Draping Test Bench for Analysis of Infiltrated Woven Fabrics in Wet Compression Molding</b>	
F. Albrecht, C. Zimmerling, C.T. Poppe, L. Kärger and F. Henning	35
<b>Tailor Made Hybrid Laminates Based on UD-Tapes - A Way to Efficient Thermoplastic Components</b>	
F. Habla, M. Kropka, M. Muehlbacher, T. Neumeyer and V. Altstädt	41
<b>Experimental Characterization of the Structural Deformation of Type IV Pressure Vessels Subjected to Internal Pressure</b>	
M. Nebe, D. Maraite, C. Braun, D. Hülsbusch and F. Walther	47
<b>Textile-Integrated Elastomer Surface for Fiber Reinforced Composites</b>	
J.E. Semar and D. May	53
<b>Dispersion of Mechanical Properties at Nanoscale Studied by Indentation Mapping of a Fiber Reinforced Composite</b>	
U.D. Hangen and D. Stauffer	59
<b>Rotational Moulding and Mechanical Characterisation of Micron-Sized and Nano-Sized Reinforced High Density Polyethylene</b>	
G. Höfler, K. Jayaraman and R. Lin	65

## Chapter 2: Metal Matrix Composites (MMC)

<b>Influence of the Process Parameters on the Penetration Depth of the Reinforcing Phase during Composite Peening for the Production of Functionally Graded Metal Matrix Composites</b>	
M. Seitz and K.A. Weidenmann	73
<b>Influence of Distinct Manufacturing Processes on the Microstructure of Ni-Based Metal Matrix Composites Submitted to Long Thermal Exposure</b>	
G. Lemos, M.C. Fredel, F. Pyczak and U. Tetzlaff	79
<b>Investigation of the Creep Resistance of a Spray-Compacted Si-Particle Reinforced Al-Based MMC (Dispal® S270)</b>	
U. Tetzlaff, A. Gerber, R. Amelang and G. Lemos	87
<b>High-Speed Laser Melt Injection of Tungsten Carbide in Highly Conductive Copper Alloys</b>	
P. Warneke and T. Seefeld	94
<b>Cold Roll Cladding of Carbon Steels</b>	
C. Etzlstorfer, A. Leitner, E. Arenholz and E. Kozeschnik	100

<b>Heat Exchange Structures Based on Copper/CNT Composite</b>	106
A. Schlott, T. Hutsch, S. Hampel, J. Lohse, T. Weißgärber and B. Kieback	
<b>Effect of Processing Conditions on Bonding Strength at Al(Si)/Diamond Interfaces</b>	115
C. Edtmaier, J. Segl, R. Koos, M. Schöbel and C. Feldbaumer	
<b>Agglomerated Tungsten Carbide: A New Approach for Tool Surface Reinforcement</b>	121
A. Ditsche and T. Seefeld	

## Chapter 3: Ceramic Matrix Composites (CMC)

<b>Investigation of Statistical Distribution of C/C-SiC Composite's Mechanical Properties</b>	131
Y. Shi, Y.L. Xiu and D. Koch	
<b>Injection Moulding of Oxide Ceramic Matrix Composites: Comparing Two Feedstocks</b>	140
M. Böttcher, D. Nestler, J. Stiller and L. Kroll	
<b>Powder Injection Molding of Oxide Ceramic CMC</b>	148
V. Piotter, M. Tueluemen, T. Hanemann, M.J. Hoffmann and B. Ehreiser	
<b>Modification of the Thermoset Injection Moulding Process for Shaping to Increase the Fibre Length in C/C-SiC Ceramics Produced by the LSI Process</b>	153
J. Stiller, D. Nestler, E. Päßler, F. Kempe, H. Wätzig, H. Ahmad, L. Kroll, M. Sommer and G. Wagner	
<b>Evaluation of Ceramic Matrix Composite Edge and Surface Damage</b>	161
R. Goller, A. Rösiger and Y. Azzaz	
<b>Custom-Made Reinforcement Structures Made of Inorganic Fibers Challenges, Chances and Technical Approaches</b>	167
M. Becker, F. Ficker, R. Miksch and S. Olbrich	
<b>Influence of Initial Fibre Length and Content Used in the Injection Moulding of CFRP on the Properties of C/C and C/C-SiC Composites</b>	171
H. Ahmad, J. Stiller, E. Päßler, D. Nestler, G. Wagner and L. Kroll	

## Chapter 4: Hybrid Structures and Materials

<b>One-Sided Resistance Spot Welding of Plastic-Metal Hybrid Joints - Characterization of the Joining Zone</b>	183
K. Szallies, M. Friedmann, M. Bielenin and J.P. Bergmann	
<b>Metal Polymer Connections: Laser-Induced Surface Enlargement Increases Joint Strength</b>	190
D. Woitun, M. Roderus, T. Bein and E. Kroner	
<b>Influence of Process Parameters, Surface Topography and Corrosion Condition on the Fatigue Behavior of Steel/Aluminum Hybrid Joints Produced by Magnetic Pulse Welding</b>	197
S. Mrzljak, N. Gelinski, D. Hülsbusch, E. Schumacher, S. Böhm and F. Walther	
<b>Sintered Connection - A Steel/CFRP Connection Module</b>	203
A. Marx, T. Hutsch, P. Schiebel, D. Feltin, F. Hoffmeister, A. Babbel, T. Weißgärber and A. Herrmann	
<b>Thermoplastic Multi-Material Nonwovens from Recycled Carbon Fibres Using Wet-Laying Technology</b>	210
M. Sauer, J. Feil, F. Manis, T. Betz and K. Drechsler	
<b>Influence of Welding Temperature and Weathering on Inductive Welded Hybrid Joints Made of Steel and TP-FRPC</b>	217
S. Weidmann and P. Mitschang	
<b>Surface Modification of Polymeric Fibers to Control the Interactions with Cement-Based Matrices in Fiber-Reinforced Composites</b>	225
A. Drechsler, R. Frenzel, A. Caspari, S. Michel, M. Holzschuh, A. Synytska, M. Liebscher, I. Curosu and V. Mechtcherine	
<b>Location-Dependent Mechanical Properties of <i>In Situ</i> Polymerized Three-Dimensional Fiber-Metal Laminates</b>	231
H.O. Werner, C. Stern and K.A. Weidenmann	
<b>Ultrasonic Torsional Welding of Metal/Glass Ceramics Joints</b>	237
A. Gester and G. Wagner	

<b>Development of Tailored Hybrid Laminates: Manufacturing of Basalt Fibre Reinforced Thermoplastic Orthoses with Aluminum Thin Sheets</b>	245
C. Karapepas, M. Trautmann, A. Todt, A. Al-Obaidi, S. Nendel, V. Kräusel and G. Wagner	
<b>Forging of Copper and Iron Plates by the Damascus Technique</b>	253
S. Strobl, W. Scheiblechner and R. Haubner	
<b>Temperature Dependency of the Deformation Behavior of Hybrid CFRP/Elastomer/Metal Laminates under 3-Point Bending Loads</b>	259
V. Sessner and K.A. Weidenmann	
<b>Polymer-Steel-Sandwich-Structures: Influence of Process Parameters on the Composite Strength</b>	266
C. Lohr, M. Muth, R. Dreher, C. Zinn, P. Elsner and K.A. Weidenmann	

## Chapter 5: Compounds, Laminated Materials, Sandwich Structures, Cellular Materials

<b>Lightweight Potential of 3D Endless Fiber Reinforcement of Polyurethane Foam Cores with Spacer Fabrics in Hybrid Sandwich Structures with Fiber Reinforced Thermoplastic Facings</b>	277
K. Schäfer, D. Nestler, K. Jahn, H. Jentzsch and L. Kroll	
<b>Analysis of the Macroscopic Behaviour of PMI Foam</b>	285
M. Nagler, M. Thor, P. Peyrer, G. Schneiderbauer, F.M. Sendner, M. Wolfahrt and R. Hinterhölzl	
<b>Modeling of Organosandwich Structures Using an RVE Model of the Thermoplastic Honeycomb Core</b>	291
A. Geyer, M. Petersilge, M. John, J. Pflug and R. Schlimper	
<b>Parameter Selection for Peel Strength Optimization of Thermoplastic CF-PA6 for Humm<sup>TM</sup></b>	297
N. Yadav and R. Schledjewski	
<b>Development of a Laser Structuring Process for Ceramic Coatings on Injection Molding Tools Produced by MOCVD</b>	303
M. Sommer, G. Fornalczky and F. Mumme	
<b>Realization of Diamond/Metal Laminates through Braze of Freestanding Diamond Foils</b>	309
T. Fromm, R. Borchardt, Y. Xuan, K. Durst and S.M. Rosiwal	
<b>Environmental Compatibility of Carbon Reinforced Concrete: Irrigated Construction Elements</b>	314
L. Weiler and A. Vollpracht	
<b>Influence on the Microstructure of Powder Metallurgical Metal Foam by Means of Mechanical Alloying</b>	320
S. Siebeck, M. Trautmann, J. Hohlfeld, T. Hipke and G. Wagner	

## Chapter 6: Joining, Manufacturing Technologies, Additive Manufacturing, Handling

<b>Ultrasonic Assisted Thermal Direct Joining of Thermoplastic Composites and Aluminum for Multi Material Design</b>	329
M. Roderus, D. Woitun and E. Kroner	
<b>Influence of Composition on Mechanical Properties of Additively Manufactured Composites Reinforced with Endless Carbon Fibers</b>	335
M. Czasny, O. Goerke, O. Kaba, S. Koerber, F. Schmidt and A. Gurlo	
<b>Surface Topography Influences on the Fatigue Behavior of Composite Joints</b>	341
T. Thäsler, J. Holtmannspötter and H.J. Gudladt	
<b>Deflection Sheaves for Elevator Application in Lightweight Design</b>	347
H. Gerlach, H. Müller, M. Klingelhöfer, R. Ziesch, M. Katkowski, M. Spieler, W. Nendel, L. Kroll and F. Bochmann	
<b>Generating Permanent and Temporary Material Compounds in FLM Processes</b>	353
C. Doerffel, R. Schmidt, M. Spieler, W. Nendel, L. Kroll, J. Petzold, D. Schreiter and M. Hunold	
<b>Analysis of a Process Approach for Production of Triaxial Braids with Locally Customized Filler Yarn Count</b>	360
E. Eschler, J. Hüls, S. Zaremba and K. Drechsler	

<b>Comparison of Electroplated Ni and PVD Ni Coating Layers after Soft Soldering Process</b>	367
J. Richter, B. Schellscheidt, A. Steenmann and T. Licht	
<b>Manufacturing CFRP-Parts Using a Modified Co-Curing Method – Fundamental Experimental Analysis</b>	372
F. Rieger, T. Rief, N. Motsch and J.M. Hausmann	
<b>Temperature- and Time-Dependent Penetration of Surface Structures in Thermal Joining of Plastics to Metals</b>	378
K. Schricker and J.P. Bergmann	
<b>Quasi-Static Characterization of Polyamide-Based Discontinuous CFRP Manufactured by Additive Manufacturing and Injection Molding</b>	386
P. Striemann, D. Hülsbusch, M. Niedermeier and F. Walther	
<b>Adhesive-Free Bonding of Web-Like Plastic-Metal Combinations at Low Temperatures</b>	392
A. Lehm, D. Romstedt, V. Schoenberner, H.T. Meyer and M. Eichler	

## Chapter 7: Structural Health Monitoring (SHM)

<b>Scalable Monitoring System for the Localization of Damaging Events in Thin-Walled CFRP Structures Based on Acoustic Emission Analysis and Neural Networks</b>	401
B. Kelkel, P. Argus and M. Gurka	
<b>Influence of Carbon Roving Strain Sensory Elements on the Mechanical Properties of Carbon Fibre-Reinforced Composites</b>	407
O. Weißenborn, E. Häntzsche, A. Nocke, S. Geller, C. Cherif and N. Modler	
<b>Influence of Sputtering Temperature and Layer Thickness on the Electrical Performance of Thin Film Strain Sensors Consisting of Nickel-Carbon Composite</b>	413
C. Karapepas, D. Nestler and G. Wagner	

## Chapter 8: Coatings

<b>BN-Based Fiber Coatings by Wet-Chemical Coating</b>	421
J. Maier, A. Nöth and K. Schönfeld	
<b>Chemical Vapor Deposition of AlZrN Coatings by the Reaction of <i>In Situ</i> Produced ZrCl<sub>4</sub> and AlCl<sub>3</sub> with NH<sub>3</sub></b>	427
E. Rauchenwald, M. Lessiak, R. Weissenbacher and R. Haubner	
<b>Thermal Stability of Natural Fibers via Thermoset Coating for Application in Engineering Thermoplastics</b>	433
N. Vellguth, T. Rudeck, M. Shamsuyeva, F. Renz and H.J. Endres	
<b>Tribological Properties of Multi-Layer a-C:H:W/a-C:H PVD-Coatings Micro-Structured by Picosecond Laser Ablation</b>	439
H. Hasselbruch, Y. Lu, H. Messaoudi, A. Mehner and F. Vollertsen	

## Chapter 9: Modeling, Simulation, Material Design

<b>Efficient Characterization and Modelling of Material Behaviour of LFT for Component Simulations</b>	447
H. Grimm-Strele, M. Kabel and J. Köbler	
<b>Mechanical Design of Intersection Points of Tailored Fiber Placement Made Carbon Fiber Reinforced Plastic Truss-Like Structures</b>	452
E. Richter, A. Spickenheuer, L. Bittrich, K. Uhlig and G. Heinrich	
<b>Effective Modeling of Load Applications in Composite Structures - Accuracy, Complexity, Computational Time</b>	461
M. Schlosser, A. Schumacher and K. Bellendir	
<b>Material Characterization and Compression Molding Simulation of CF-SMC Materials in a Press Rheometry Test</b>	467
D. Schommer, M. Duhovic, V. Romanenko, H. Andrä, K. Steiner, M. Schneider and J.M. Hausmann	
<b>Efficient Multiscale Methods for Viscoelasticity and Fatigue of Short Fiber-Reinforced Polymers</b>	473
F. Welschinger, J. Köbler, H. Andrä, R. Müller, M. Schneider and S. Staub	

<b>Investigation on the Influence of Pressure Terms in a Volume-Averaged Energy Balance in the Modelling of Liquid Composite Moulding Processes</b>	480
R.G. Sebastian, C. Obertscheider, E. Fauster and R. Schledjewski	
<b>A Novel Simulative-Experimental Approach to Determine the Permeability of Technical Textiles</b>	487
T. Schmidt, F. Schimmer, A. Widera, D. May, N. Motsch and C. Bauer	
<b>Flexible Graph Syntax for the Topology Optimization of Crashworthiness Profile Structures Made from Thermoplastic Composites</b>	493
D. Schneider, A. Schumacher, T. Donhauser, A. Huf and S. Schmeer	
<b>Sensitivity Study of Material Input Data on FE Forming Results for Wrinkling and Shearing of Fiber Reinforced Thermoplastic Parts</b>	500
B. Engel and J. Graef	

## Chapter 10: Recycling, Repair

<b>Innovative rC Staple Fiber Tapes - New Potentials for CF Recyclates in CFRP through Highly Oriented Carbon Staple Fiber Structures</b>	509
O. Reichert, L. Ausheyks, S. Baz, J. Hehl and G.T. Gresser	
<b>RecyCarb: Process Optimization and On-Line Monitoring in the Recycling of Carbon Fibre Waste for the Re-Use in High-Grade Fibre Reinforced Plastics</b>	515
M. Hofmann, H. Fischer, K. Heilos and A. Miene	
<b>Novel Approach in B-Staging of an Epoxy Resin for Development of rCF Non-Woven Prepregs for RTP Processing</b>	521
C. Goergen, A. Klingler, S. Grishchuk, D. May, B. Wetzel and P. Mitschang	
<b>Development of a Novel Textile Process for the Production of Highly Oriented Nonwovens Made from Recycled Carbon Fibres</b>	527
M. Petrich, C. Hoffmeister and A. Herrmann	

## Chapter 11: Applications

<b>Liquid Metal Embrittlement of Copper Brazed Plate Heat Exchangers</b>	535
R. Haubner, S. Strobl, L.P. Bichler and P. Linhardt	
<b>Development of a Variable Gridshell for Application in Mobile Architecture</b>	541
E. Rudolph, C. Müller, A. Ehrlich, S. Gelbrich and L. Kroll	
<b>CMC-Jacketed Piping for High-Temperature Applications: Concept, Laboratory Tests and Large-Scale Application Test</b>	547
M. Friedrich, M. Huang, A. Jüngert, A. Klenk, S. Weihe and K. Metzger	

## Chapter 12: Testing and Characterization, Quality Assurance

<b>Experimental Characterization of the Fiber Angles of Multiple Curved Laminate Segments Using Prepreg-Based Carbon Fiber Reinforced Polymers as a Structure for a Non-Engaging Bellows Coupling</b>	555
C. Oblinger, A. Baeten and K. Drechsler	
<b>Development of a 25kN <i>In Situ</i> Load Stage Combining X-Ray Computed Tomography and Acoustic Emission Measurement</b>	563
F. Thum, P. Potstada and M.G.R. Sause	
<b>Assessment of Secondary Fiber Print-Through Effects on Class-A CFRP Parts Produced with Highly Cost Efficient Processes</b>	569
D. Metzger, J. Meeß, M. Heine and T. Henke	
<b>Microscopic Measurement of Strain Fields with Digital Image Correlation and Comparison to Finite Element Modelling</b>	575
M. Korkisch and M.G.R. Sause	
<b>Passive Thermography for Detection of Damaging Events during Quasi-Static Tensile Testing</b>	581
V. Popow and M. Gurka	

<b>Region-of-Interest X-Ray Tomography for the Non-Destructive Characterization of Local Fiber Orientation in Large Fiber Composite Parts</b>	587
S. Zabler, K. Schladitz, K. Dremel, J. Graetz and D. Dobrovolskij	
<b>Optimization of the Specimen Geometry of Unidirectional Reinforced Composites with a Fibre Orientation of 90° for Tensile, Quasi-Static and Fatigue Tests</b>	594
C. Schneider, M. Drvoderic, C. Schuecker and G. Pinter	
<b>Model-Based Quality Control System for Error Reduction in the Thermoforming Process</b>	598
R. Vocke, J. Stempin, P. Schiebel, A. Herrmann and A. Fischer	
<b>Combined <i>In Situ</i> X-Ray Computed Tomography and Acoustic Emission Analysis for Composite Characterization - A Feasibility Study</b>	604
M. Bartkowiak, L. Schoettl, P. Elsner and K.A. Weidenmann	
<b>Controlling Moisture Content of Natural Fibres in RTM-Process</b>	610
M. Salzmann and R. Schledjewski	
<b>Mechanical and Fracture Mechanical Properties of Matrix-Reinforced Carbon Fiber Composites with Carbon Nanotubes</b>	615
G. Sinn, G. Singer, L. Jocher, M.M. Unterlass, H. Rennhofer, U. Windberger, J. Wendlinsky, W. Stöger, K.H. Semlitsch and H.C. Lichtenegger	
<b>Novel Approach for the Lifetime Prediction of Composite Materials under Static Loads</b>	620
S. Gloggnitzer, G. Pilz, C. Schneider and G. Pinter	
<b>Testing of Composite Material for Transport Tanks for LNG</b>	625
P.W. Kutz, J. Werner and F. Otremba	

## Chapter 13: Renewable Raw Materials, Sustainability

<b>Potential for Use of Veneer-Based Multi-Material Systems in Vehicle Structures</b>	633
D.B. Käse, G. Piazza, E. Beeh, H.E. Friedrich, D. Kohl, H. Nguyen, D. Berthold and C. Burgold	
<b>Composite Materials Made of Basalt Fibres and Biobased Matrix Material for Technical Applications</b>	639
S. Buschbeck, F. Tautenhain, C. Reichelt, R. Rinberg and L. Kroll	
<b>Novel Lightweight Semi-Finished Products Made of Poplar Veneer Plywood with Basalt Fibre Reinforcement</b>	645
F. Tautenhain, R. Rinberg and L. Kroll	
<b>Bio-Based and Renewable Filler Materials for Thermoset Compounds</b>	650
F. Gortner and P. Mitschang	
<b>Efficient Process Chain for Processing Natural Fiber Reinforced Thermoplastics</b>	658
F. Gortner, P. Mitschang, W. Neu, A. Dittrich, L. Schmidt, I. Braun, L. Zhao, A. Ziesak and V. Schäfer	