

1. Record Nr.	UNINA9910476876403321
Autore	Trauth Anna
Titolo	Characterisation and Modelling of Continuous-Discontinuous Sheet Moulding Compound Composites for Structural Applications / / Anna Trauth
Pubbl/distr/stampa	Karlsruhe : , : KIT Scientific Publishing, , 2020
Descrizione fisica	1 online resource (468 pages) : illustrations
Collana	Schriftenreihe des Instituts fur Angewandte Materialien, Karlsruher Institut fur Technologie
Disciplina	731.42
Soggetti	Modeling Mechanical engineering
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	List of Figures xv -- List of Tables xxiii -- List of Abbreviations and Symbols xxv -- 1 Introduction. 1 -- 1.1 Motivation . 1 -- 1.2 Scope and objective. 5 -- 1.3 Contribution to the current state of research. 6 -- 1.4 Outline of this dissertation 8 -- 2 Current state of research 9 -- 2.1 Definition of hybrid materials 9 -- 2.2 Composite materials . 14 -- 2.2.1 Definition and fundamentals 14 -- 2.2.2 Basic mechanisms of fibrous reinforcement. 16 -- 2.3 Sheet moulding compound composites. 21 -- 2.3.1 Definition and terminology delimitation 21 -- 2.3.2 Discontinuous SMC composites 21 -- 2.3.3 Continuous SMC composites 57 -- 2.4 Hybrid composites . 61 -- 2.4.1 Definition, motivation and development -- of hybrid composites . 62 -- 2.4.2 Evaluation of hybridisation effects . 65 -- 2.4.3 Existing concepts of hybrid SMC . 68 -- 2.5 Research questions . 82 -- 3 Materials and specimen geometries 85 -- 3.1 Manufacturing of SMC composites 85 -- 3.1.1 Composition of resin systems . 85 -- 3.1.2 Manufacturing of semi-finished sheets 87 -- 3.1.3 Manufacturing of compression moulded sheets . 89 -- 3.1.4 Manufacturing of pure resin sheets 92 -- 3.1.5 Manufacturing of demonstrator part 93 -- 3.2 Specimen preparation and geometry 94 -- 3.2.1 Water-jet cutting and milling 94 -- 3.2.2 End tabs. 95 -- 3.2.3 Specimen geometries . 95 -- 4 Experimental setups, procedures and data evaluation 103 -- 4.1

Characterisation strategy	103
4.2 Characterisation at the coupon level	105
4.2.1 Microstructural characterisation	105
4.2.2 Macrostructural characterisation	106
4.3 Characterisation at the structure level	114
4.3.1 Quasi-static puncture testing	114
4.3.2 Dynamic puncture testing	116
4.4 Characterisation at the component level	118
4.5 Data evaluation	121
5 Analytical modelling	123
5.1 Description of modelling approach	123
5.2 Micromechanics and homogenisation methods	124
5.2.1 Fundamentals of homogenisation	124
5.2.2 Analytical modelling of fibre reinforced polymers	128
5.3 Classical laminate theory	133
5.3.1 Macromechanical characterisation of a lamina	134
5.3.2 Macromechanical characterisation of a laminate	134
5.4 Analytical modelling of hybrid composites	138
5.4.1 Rule of hybrid mixtures	139
5.4.2 Tensile and flexural modulus based on classical laminate theory	140
6 Results	143
6.1 Evaluation of testing methods and preliminary studies	143
6.1.1 Tensile properties of discontinuous SMC composites	144
6.1.2 Tensile properties of continuous SMC composites	150
6.1.3 Flexural properties of SMC composites	152
6.2 Microstructural analysis	158
6.2.1 Fibre volume content	158
6.2.2 Fibre orientation distribution	164
6.2.3 Interface of continuous-discontinuous SMC	173
6.3 Mechanical properties and failure at the coupon level	176
6.3.1 Tensile and compressive properties of -- polyester-polyurethane hybrid resin	176
6.3.2 Process-induced material properties of -- discontinuous glass fibre SMC	179
6.3.3 In-plane loading of SMC composites	190
6.3.4 Out-of-plane loading of SMC composites	229
6.4 Mechanical properties and failure at the structure level	237
6.4.1 Puncture properties of discontinuous glass fibre SMC	238
6.4.2 Puncture properties of continuous carbon fibre SMC	248
6.4.3 Puncture properties of continuous-discontinuous glass/carbon fibre SMC	256
6.5 Mechanical properties and failure at the component level	268
6.6 Analytical stiffness prediction	271
6.6.1 Analytical stiffness prediction of discontinuous glass fibre SMC	272
6.6.2 Analytical stiffness prediction of continuous carbon fibre SMC	277
6.6.3 Analytical stiffness prediction of continuous-discontinuous glass/carbon fibre SMC	279
7 Discussion	283
7.1 Testing methodology and preliminary studies	283
7.2 Material behaviour of unsaturated polyester-polyurethane two-step curing hybrid resin system	285
7.3 Discontinuous glass fibre SMC	287
7.3.1 Microstructural aspects of discontinuous glass fibre SMC	287
7.3.2 Mechanical behaviour and damage evolution of discontinuous glass fibre SMC	291
7.4 Continuous carbon fibre SMC	301
7.4.1 Microstructural aspects of continuous carbon fibre SMC	301
7.4.2 Mechanical behaviour and damage evolution of continuous carbon fibre SMC	302
7.5 Continuous-discontinuous glass/carbon fibre SMC	308
7.5.1 Microstructural aspects of continuous-discontinuous glass/carbon fibre SMC	308
7.5.2 Mechanical properties, damage evolution and hybridisation effect	310
8 Final remarks	347
8.1 Summary	347
8.2 Conclusion	356
Bibliography	361
A Appendix	403
A.1 Influence of subset size and step size	403
A.2 Influence of edge preparation	405
A.3 Tensile properties of discontinuous glass fibre SMC (2D)	406
A.4 Tensile properties of discontinuous glass fibre SMC (1D)	407
A.5 Compressive properties of discontinuous glass fibre SMC	408
A.6 Tensile and compressive properties of continuous carbon fibre SMC	409
A.7 Flexural properties of continuous carbon fibre SMC	410
A.8 Flexural properties of continuous-discontinuous glass/carbon fibre SMC	411
A.9 Classical laminate theory: calculations	412

The main objective of this work is to significantly deepen the understanding of the material and the structural behaviour of continuous-discontinuous SMC composites, following a holistic approach to investigate microscopic aspects, macroscopic mechanical behaviour as well as failure evolution at the coupon, structure and component level. In addition, criteria to evaluate the effect of hybridisation are introduced and modelling approaches are presented and discussed.
