Institute of Engineering Mechanics - Karlsruhe Institute of Technology (KIT)

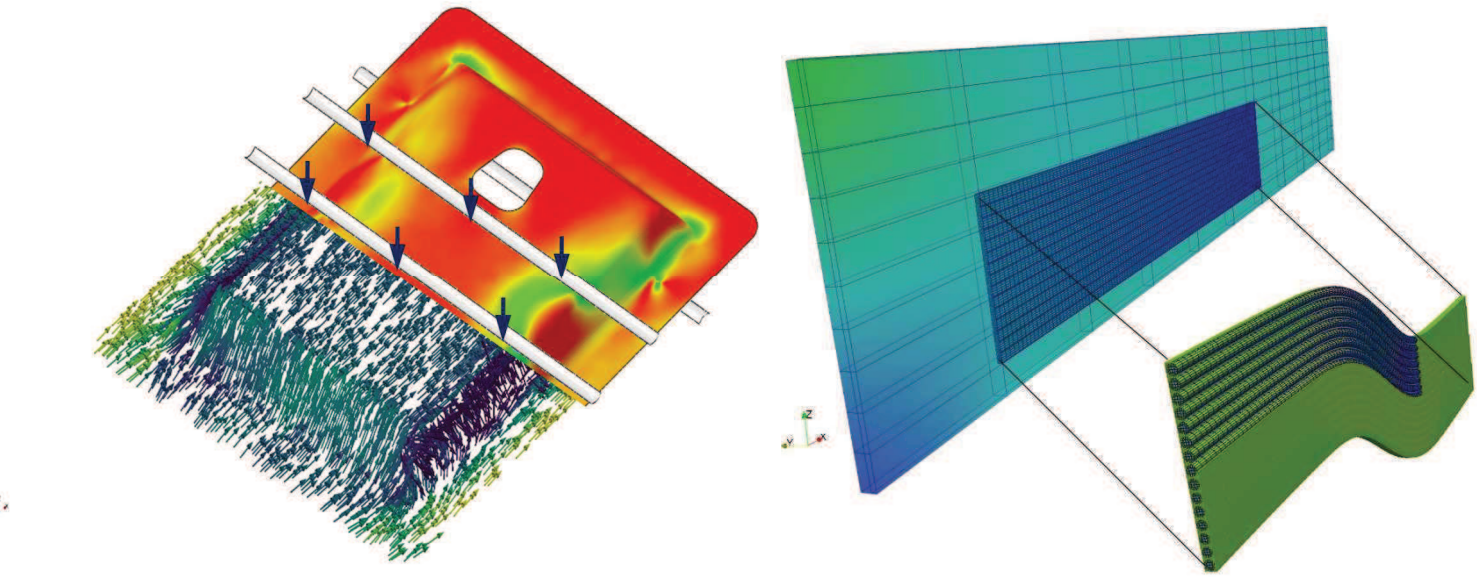
Chair of Engineering Mechanics - University of Paderborn

International Research Training Groups
ViVaCE (IRTG 1627) and CoDiCoFRP (IRTG 2078)

Virtual Materials and their Validation: German-French School of Computational Engineering

Integrated Engineering of Continuous-Discontinuous Long Fiber Reinforced Polymer Structures

31st International Workshop
Research in Mechanics of Composite 2018



December 4-7, 2018, Bad Herrenalb, Germany

31st International Workshop Research in Mechanics of Composite 2018

Winter School of the International Research Training Groups ViVaCE (IRTG 1627) and CoDiCo (IRTG 2078)

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The Workshop

The yearly Workshops in Research in Mechanics of Composite alternately organized by **Prof. Rolf Mahnken, Chair of Engineering Mechanics, University of Paderborn**, and **Prof. Thomas Böhlke, Institute of Engineering Mechanics, Karlsruhe Institute of Technology (KIT),** have a long and successful history with respect to their familiar atmosphere allowing intensive discussions on focused topics.

In 2018, the special format of this workshop as a Winter School brings together doctoral researchers from two International Research Training Groups, actually funded by the German Research Foundation (DFG), to stimulate their interaction in scientific as well as personal aspects: **IRTG 1627 ViVaCE "Virtual Materials and their Validation: German-French School of Computational Engineering"** at Leibniz University of Hannover (with ENS Paris Sacly in France as foreign partner institution) and **IRTG 2078 CoDiCoFRP "Integrated engineering of continuous-discontinuous long fiber reinforced polymer structures"** at KIT (with the University of Western Ontario in Canada as foreign partner institution). Therefore, besides scientific presentations of members as well as foreign partners of both IRTGs, short contributions of the doctoral researchers as well as poster sessions of the two IRTGs have been integrated as important measures of the qualification program of the doctoral researchers. A social program will be, additionally, offered during this Winter School.

Figures at Front Page:
left: Demonstrator structure of IRTG 2078 including molding simulation flow directions and fiber-matrix interface damage due to four-point bending, Tarkes Pallicity et. al, Karlsruhe Institute of Technology (KIT)
right: Multiscale Simulation of Fibre kinking in FRP Composites, Samira Hosseini, Leibniz University Hannover

IRTG 1627 ViVaCE "Virtual Materials and their Validation", German-French School of Computational Engineering

www.irtg1627.uni-hannover.de

With the development of computer simulations, a powerful tool was created in the last 50 years which enhances engineering science and design in many ways. Still there is a long way to go for the development of robust and reliable simulation tools for virtual testing of materials and structures. This is especially true when validated results of numerical simulations are needed. Due to their mathematical and physical complexity, in many cases still no robust simulation methods exist. Furthermore the physical behaviour is often not satisfactorily described. Here multi-scale methods can help in both directions. They provide a new approach by taking different scales and their physics into account but provide also more insight of how complex processes develop within a material or a structure.

The aim of the Research Training Group is to set up a forum for research and development of newest methods related to computational technologies, virtual testing and validation. The emphasis is to provide a place in which gifted Master Students, PhD students and Post-docs can perform leading international research in the interdisciplinary area of the application of virtual testing methods to materials and structures. Due to the participation of scientists and teachers from different fields such as Mechanics and Computational Mechanics, Civil and Mechanical Engineering and Applied Mathematics the knowledge base will be broadened. New insights will be gained by the interdisciplinary cooperation. Thus the Research Training Group will provide a stimulating education and research environment for young scientists. Furthermore strong interaction with leading scientists from France in the area of multi-scale techniques, experimental methods and composite structures will complement the scientific approaches and the educational spectrum and in this way will generate additional impact in teaching and research.

The research of this IRTG is subdivided into three main categories:

A) Development, simulation and experimental testing of materials and structures

B) Multi-scale modeling of materials including damage, fatigue and uncertainty quantification

C) Mathematical analysis and tool development for validation and optimization of materials and structures

Chairman: Prof. P. Wriggers, *Institute of Continuum Mechanics*

Co-Chairman: Prof. Dr. O. Allix, *Laboratory of Mechanics and Technology from ENS Paris –Sacly*

Current German Principle Investigators:

- Prof. B.-A. Behrens, *Institute of Forming Technology and Machines, Leibniz University of Hannover*
- Prof. Dr. J. Escher, *Institute of Applied Mathematics, Leibniz University of Hannover*
- Dr.-Ing. S. Löhnert, *Institute of Continuum Mechanics, Leibniz University of Hannover*
- Prof. Dr. H. J. Maier, *Institute of Material Science, Leibniz University of Hannover*
- Prof. Dr.-Ing. habil. U. Nackenhorst, *Institute of Mechanics and Computational Mechanics, Leibniz University of Hannover*
- Prof. Dr.-Ing. Habil. R. Rolfes, *Institute of Structural Analysis, Leibniz University of Hannover*
- Associate Prof. Dr. X. Zhuang, *Institute of Continuum Mechanics, Leibniz University of Hannover*
- Prof. Dr.-Ing. M. André, *Mechanical Engineering and Biotechnology, University of Applied Sciences and Arts, Hannover*

IRTG 2078: Integrated Engineering of Continuous-Discontinuous Long Fiber Reinforced Polymer Structures

www.grk2078.kit.edu

Continuous-discontinuous long fiber reinforced polymer structures (CoDiCoFRP) represent an important and new class of lightweight materials. This class of materials has a significant potential for energy savings due to the high specific stiffness and strength as well as the variety of design options in diverse technical applications, e.g., in vehicle construction.

In contrast to the continuous fiber reinforced composites of non-crimp or woven fabrics, which are used, for example, in the aircraft industry, there is still a lack of integrated and experimentally proven concepts for the manufacturing, modeling and dimensioning of combinations of discontinuously and continuously reinforced polymer structures. Reasons can be identified, on the one hand, in the complexity of the processes in manufacturing discontinuously reinforced polymers themselves and consequently in the resulting heterogeneous, anisotropic and nonlinear material and structural properties, and on the other hand, in the resulting bonding problem of both material types induced by the manufacturing process.

Especially in the field of application of three-dimensional load-bearing structures, there is considerable demand for both the enhancement of scientific methods as well as the education of engineers, who have an interdisciplinary understanding of the corresponding process and material techniques along with the necessary simulation and product development methods.

In recent years, there has been considerable progress with respect to characterization and numerical methods. Nowadays, it is possible to combine the methodological progress in material science, computational mechanics, production techniques and design methods in an integrated approach.

The main objective of the IRTG is, therefore, to enable the efficiently structured education of doctoral candidates in this strategically important but not yet developed field of continuous-discontinuous long fiber reinforced polymer structures, by taking advantage of the complementary competencies of the applicants from Germany and Canada.

The complementary research emphases of the participating institutions are respectively strongly cross-linked to the local national industries and research structures, ensure a versatile education and, in the medium term, a transfer of research results to industrial applications. Our Canadian partners at the University of Western Ontario, University of Windsor, University of Waterloo, McMaster Manufacturing Research Institute, McGill University as well as University of Toronto integrate their research expertise into the IRTG. Moreover, an international double supervision of the doctoral researchers at KIT and in Canada has been implemented.

Within this IRTG, KIT closely cooperates with the Fraunhofer Institute of Chemical Technology (ICT) in Pfinztal and Fraunhofer Institute of Mechanics of Materials (IWM) in Freiburg, using, e.g., their experimental facilities. Additionally, the Fraunhofer Project Center for Composite Research at the University of Western Ontario (FPC@Western) is part of the research network directly linking the KIT activities to the Canadian site.

Spokesperson on German Side: Prof. Dr.-Ing. habil. Thomas Böhlke, *Institute of Engineering Mechanics, Karlsruhe Institute of Technology (KIT)*

Spokesperson at Canadian Side: Prof. Dr. Jeffrey T. Wood, *University of Western Ontario (UWO), London*

Principal Investigators on the German Side:

- Prof. Dr.-Ing. habil. Thomas Böhlke (spokesperson), JP Dr. rer. nat. Matti Schneider, *Institute of Engineering Mechanics (ITM), KIT*
- Prof. Dr.-Ing. Dr. h. c. Albert Albers, *Institute of Product Engineering (IPEK), KIT*
- Prof. Dr.-Ing. Peter Elsner*, Prof. (apl.) Dr.-Ing. Kay André Weidenmann, *Institute for Applied Materials – Materials Science and Engineering (IAM-WK), KIT, *also at Fraunhofer Institute for Chemical Technology (ICT)*
- Prof. Dr.-Ing. Jürgen Fleischer, Prof. Dr.-Ing. Gisela Lanza, Prof. Dr.-Ing. habil. Volker Schulze, *Institute of Production Science (wbk), KIT*
- Prof. Dr. rer. nat. Peter Gumbsch*, Prof. Dr. rer. nat. Britta Nestler, PD Dr.-Ing. habil. Jörg Hohe**, *Institute for Applied Materials – Computational Materials Science (IAM-CMS), KIT, *also at Fraunhofer Institute for Mechanics of Materials (IWM), **only at IWM*
- Prof. Dr.-Ing. Frank Henning*, Dr.-Ing. Luise Kärger, *Institute of Vehicle System Technology (FAST), KIT, *also at Fraunhofer Institute for Chemical Technology (ICT), University of Western Ontario (UWO), and Fraunhofer Project Center (FPC)*
- Prof. Dr.-Ing. habil. Thomas Seelig, *Institute of Mechanics (IFM), KIT*

The successful NSERC Proposal for a Collaborative Research and Training Experience Program (CREATE) with the title “Advanced Polymer Composite Materials and Technologies” of the Canadian partners was coordinated by Prof. Jeffrey Wood.

On the Canadian side, in total, the following scientists act as Principal Investigators:

- Prof. Dr. Jeffrey T. Wood, Prof. Dr. Andrew Hrymak, Prof. Dr. Colin Denniston, Prof. Dr. Takashi Kuboki, Prof. Dr. Darren Meister, Prof. Ovidiu-Remus Tutunea-Fatan, *University of Western Ontario*
- Prof. Dr. Kaan Inal, Prof. John Montesano, *University of Waterloo*
- Prof. Dr. William Altenhof, Prof. Dr. Jennifer Johrendt, Prof. Bruce Minaker, Prof. Dr. Jill Urbanic, *University of Windsor*
- Prof. Dr. Michael Thompson, *Mc Master Manufacturing Research Institute*
- Prof. Dr. Pascal Hubert, *McGill University*
- Prof. Kamran Behdinan, *University of Toronto*

Tuesday, December 4, 2018

Time	Authors	Title of Lecture
12:30 - 15:00	Arrival and Registration	possibility to have Lunch between 12:30 and 13:30
15:00 – 15:45	Peter Lenz, Rolf Mahnken	Mean-field homogenization of multi-layered thermo-chemo-elastic composites including damage
15:45 - 16:30	Federica Daghia	Original approaches for the experimental characterization of composite's delamination: dealing with non-standard geometries and environmental loadings
16:30 – 16:45	Coffee break	
16:45 - 17:30	Xiaozhe Ju, Rolf Mahnken	Goal-oriented adaptivity on mean-field and full-field homogenization methods with a view to hierarchical unit cells
17:30 - 19:00	Xiaoying Zhuang	Computational multiscale modeling and uncertainty analysis of polymer matrix nanocomposites
19:00 - 20:00	Dinner	
20:00 - 21:00	Poster Session IRTG 2078	

Wednesday, December 5, 2018

Time	Authors	Title of Lecture
09:00 – 09:22	Miriam Bartkowiak	IRTG 2078: Research Area Characterization
09:23 – 09:45	Julian Bauer	IRTG 2078: Research Area Simulation
09:45 – 10:07	Nils Meyer	IRTG 2078: Research Area Design
10:08 – 10:30	Daniel Kupzik	IRTG 2078: Research Area Technology
10:30 - 11:00	Coffee break	
11:00 - 11:22	Pascal Pinter	IRTG 2078 Start up: Machine learning in materials science
11:23 - 11:45	Milad Amin Ghaziani	IRTG 1627: Development, simulation and experimental testing of materials and structures
11:45 - 12:07	Weiran Zhang	IRTG 1627: Multi-scale modeling of materials including damage, fatigue and uncertainty quantification
12:08 - 12:30	Philipp Hartmann	IRTG 1627: Mathematical analysis and tool development for validation and optimization of materials and structures
12:30 - 13:30	Lunch	
13:30 - 14:15	Philippe Boisse	Specific shell and generalized continuum models for textile composite forming
14:15 - 15:00	Gleb Meirson	LFT-D flow simulation
15:00 - 15:45	Andy Hrymak	Carbon filled micromoldings
15:45 - 16:15	Coffee break	
16:15 - 17:00	Young-Bin Park	Thermoplastic RTM(T-RTM) of continuous carbon fiber composites with nanomaterials and interfacial reinforcement
17:00 - 17:45	Wooseok Ji	Unified numerical framework to model interactive failure modes in laminated composite structures
18:30 - 21:00	Conference Dinner	

Thursday, December 6, 2018

Time	Authors	Title of Lecture
09:00 - 12:30	Social Program	
12:30 - 13:30	Lunch	
13:30 - 14:15	Pietro Carrara	A new variational phase-field framework to simulate fatigue fracture
14:15 - 15:45	Udo Nackenhorst	Constitutive modeling of rubber
15:45 - 17:00	Poster Session IRTG 1627	
17:00 - 17:45	Fodil Meraghni	Characterization and multiscale modelling of mechanical behavior and damage in glass and carbon fibers based SMC under quasi-static, dynamic and fatigue loading
17:45 - 18:30	Dimitros Anagnostou	Hierarchical micromechanical modeling in SMC-Hybrid Composites
18:30 - 19:30	Dinner	
19:30 - 21:00	Organizational meeting of IRTG 1276 and IRTG 2078	

Friday, December 7, 2018

Time	Authors	Title of Lecture
09:00 - 09:45	Manfred Wilhelm	Introduction to Rheology
09:45 - 10:30	Christian Gerendt	Fatigue damage modeling of composites: Application to FML joints
10:30 - 11:00	Coffee break	
11:00 - 12:30	Matti Schneider	FFT-based computational homogenization
12:30	Closing and Departure Lunch	

Conference Venue and Location

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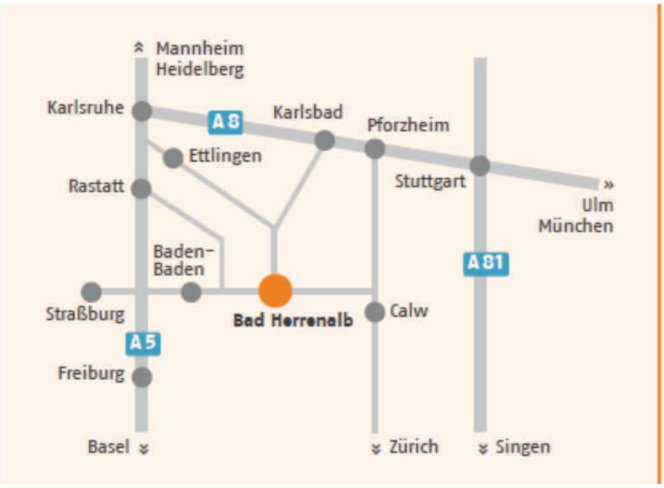
www.hdk.ev-akademie-baden.de/html/hausprospekt641.html



By public transport: Take tram S1 leaving once an hour in front of Karlsruhe Main-Train-Station to Bad Herrenalb (duration about 30 Min.). Upon arrival in Bad Herrenalb, you can take a taxi or even walk to the conference venue (5-10 Min.).

By car: Karlsruhe - Ettlingen - Bad Herrenalb. In the center of Bad Herrenalb turn left to the direction of Dobel (Pforzheim). The conference venue is then located about 500 m on your left.

Contact

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