FASERINSTITUT FIBRE BREMEN

PROJECTS

Hybrid Matrices

Development of a form and molecular fit between woven, thermoset and thermoplastic in an innovative hybrid interlayer

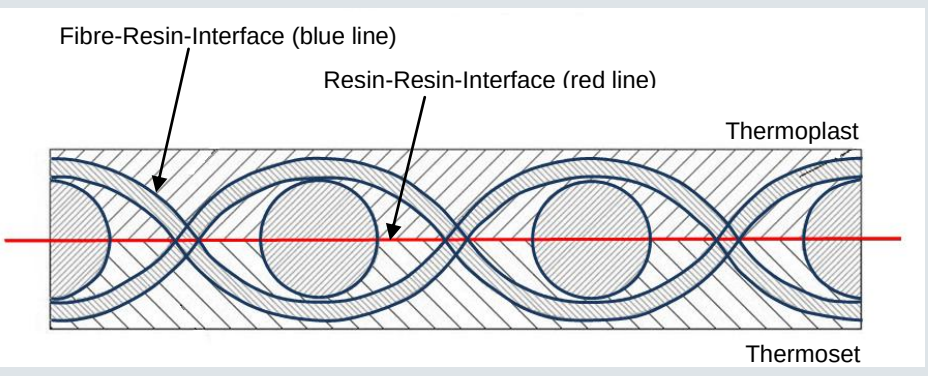
Motivation and Goal

In the past years, the use of fiber reinforced plastics increased significantly due to an increasing demand for lighweight materials for aerospace. Especially the joining techniques of composites represents a current major challenge. Conventional state of the art joining techniques are riveting and bolting which expensive in mounting and heavy in weight. Furthermore, drill holes damage load-bearing fibres and reduce the mechanical performance of the composite.

In the project Hybrid Matrices, a new semi-finished prepreg product will be developed. It is characterized by a thermoset compound with a single woven layer on top combining a subconsolidated side of thermoset and thermoplast (figure). During the manufacturing process, this prepreg will be laid as the upper layer of the thermoset composite to make it weldable through the thermoplastic surface for joining (fusion bonding).

Approach

Thermoplastics and thermosets will be combined in one semi-finished prepreg product with a textile interlayer. Two adhesion forces between thermoplastic and thermoset include form and molecular fit. Form fit will be achieved with a new developed woven textile with high undulations. This ensures that warp and weft yarns of the woven fabric change frequently the resin side. Therefore, thermoplastic and thermoset resin need to be exactly in the middle of the prepreg material for achieving the best performance of the form fit. Additionally, it is expected that strong chemical bonds may exist between thermoplastics and thermosets, whose verification and detection are a central part of the presented investigations.



Main principle of the hybrid matrices with woven interlayer

The project hybrid matrices combines specialized industrial partners with research institutes. The partners include E&M Industrietechnik GmbH and Rucks Maschinenbau GmbH who will adopt available weaving machines and hot presses for the ideal manufacturing regarding the requirements of hybrid matrices. Cetex gGmbH will develop a continuous manufacturing of prepreg material via a calender. STFI develops the manufacturing of prepreg material in a discontinuous way with semi-consolidation of the thermplastic matrix. COTESA is a Tier1 supplier for the aircraft industry and focus on prepreg manufacturing technqiues via autoclave and have excellent test equipment.

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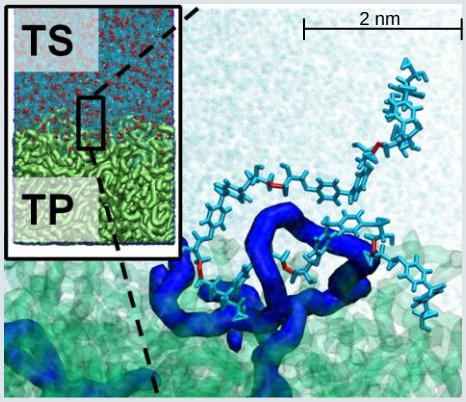
FIBRE focus on the interface analysis between fibre-resin and resin-resin. The interactions at the interface between thermoset and thermoplastic are investigated with atomistic simulations in comparison to experiments. In particular, classical molecular dynamics simulations of both matrix materials are used to study the interdiffusion of two bulk systems. The procedure includes curing by cross-linking of the epoxy matrix and tensile testing to study the interphase adhesion. Furthermore ab-initio simulations based on density functional theory is used to predict chemical bonds between thermoset and thermoplastic matrices. In this way functional groups involved in the reaction pathway are identified. The results are used to calculate vibrational modes for the direct interpretation of experimentally measured vibrational spectra identifying the chemical bond between the matrices. Furthermore, FIBRE supports the projects by the discontinuous manufacturing method due to infusion/injection processes and in joining by welding. Imaging methods like scanning electron microscope or X-ray micro computer tomography will be used to evaluate the composite overall properties.



Atomistic view on Thermoset-Thermoplast-Interface (TS/TP) based on Molecular Dynamics Simulations

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Funding

The project has been funded through budgetary resources from the federal ministry for education and research (BMBF) as part of the futureTex-Program to whom we would like to express our sincere thanks.
Funding period: 11/2017 – 10/2020

Federal Ministry for Economic Affairs and Energy

Project Partners

- Sächsisches Textilforschungsinstitut e.V. (STFI), Chemnitz
- Cetex Institut für Textil- & Verarbeitungsmaschinen gGmbH, Chemnitz
- COTESA GmbH, Mittweida
- Rucks Maschinenbau GmbH, Glauchau
- E & M Eichler und Meurers Industrietechnik GmbH, Chemnitz

Faserinstitut Bremen e.V.

The Faserinstitut Bremen e.V. is active in research and development tasks in areas of testing, development and processing of fibres, textile preforms and carbon fibre reinforced plastics. The department of Composite Structures and Processes focuses on the examination of continuous process chains and the design of components for aircraft and automotive industry and other industrial fields.

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