TECHNISCHE UNIVERSITÄT
CHEMNITZ

Faculty of Mechanical Engineering
Institute of Lightweight Structures
Department of Lightweight Structures and Polymer Technology

Call for Student Research Project

Topic: Evaluation of MXene-modified short-fibre C/C-SiC composites via liquid silicon infiltration

Explanation of the content of the task:

Fibre-reinforced ceramics such as C/C-SiC combine high stiffness and temperature resistance with improved fracture toughness compared to monolithic ceramics, and are therefore attractive for lightweight, high temperature structural applications. One industrially relevant route to silicon-carbide-based fiber-reinforced ceramics is the liquid silicon infiltration (LSI) process. It typically proceeds in three steps: CFRP preform, A carbon fibre reinforced plastic is produced from a polymer with high carbon yield (carbon precursor). Pyrolysis: During heat treatment in inert atmosphere, the polymer matrix is converted into carbon. The associated shrinkage generates a connected crack and pore network, resulting in a porous C/C composite. Siliconization: Liquid silicon infiltrates this network and reacts with the carbon to form SiC on the crack and pore walls. The final material is a heterogeneous C/C-SiC with carbon fibres as reinforcement and a dual-phase C/SiC matrix. The choice of polymer and additional fillers strongly influences all three stages (shaping, carbon yield, crack morphology, pore structure) and thus the microstructure and properties of the final composite.

A recent study on SiC ceramics with a small MXene addition showed that, after high-temperature processing, the MXene no longer remained as a separate 2D phase but decomposed into graphite-like, carbon rich flakes located along SiC grain boundaries. These MXene derived flakes were associated with measurable increases in hardness and fracture toughness compared with unmodified SiC, and were observed to act as crack-bridging and crack-deflecting features in the ceramic matrix. Building on this idea, the goal of this student project is to explore whether MXene type additives can be introduced via compounding into short-fibre C/C-SiC and survive the LSI process in a form that can influence the crack network and matrix microstructure. The focus in this first step is on matrix level addition (dispersion in the carbon-precursor resin/direct addition during compounding). The project aims to establish first process-structure-property relationships for MXene-modified carbon precursors in the LSI process and to assess whether such additives are a promising route for further toughening concepts in short-fibre C/C-SiC.

The work program includes:

- Literature research on MXene-reinforced composites and C/C-SiC manufactured by LSI
- Selection of a suitable MXene system
- Planning and realisation of experimental work
- Compounding with short carbon fibres using a measuring kneader and production of test specimens via micro injection moulding
- Pyrolysis of the CFRP specimens to obtain porous C/C, followed by liquid silicon infiltration
- Characterisation of the specimens (density/porosity, microstructure, MXene-derived phase distribution, mechanical properties etc.)
- Summarising and evaluating the results in the form of a written scientific paper

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Requirements:

- Basic knowledge of materials science, in particular polymers and/or ceramics
- Interest in experimental laboratory work (e.g. thermal analysis, porosity measurements, microscopy, mechanical testing)
- Ability to work independently in a structured manner and willingness to familiarize yourself with new topics

The assignment may be expanded or shortened during the course of the work. The work must be prepared as an individual piece of work and submitted in written and digital form. Applicants must be enrolled in a master's program at Technische Universität Chemnitz in the field of engineering or natural sciences. The proposed work must be carried out as a student research project.

If you are interested, please send your application (CV and current transcript of records) by email to **shaun-george.antony@mb.tu-chemnitz.de** by **19 June 2026** and also indicate your earliest possible starting date.

If you have any further questions, please feel free to contact
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