

Call for Research Project

Topic: Evaluation of polyethylene as a carbon precursor for the liquid silicon infiltration process

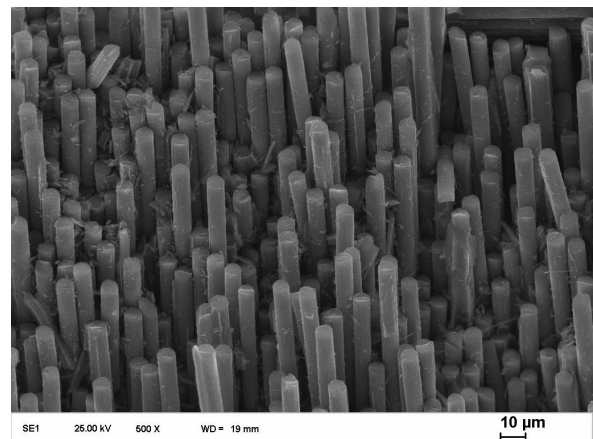
Explanation of the content of the task:

Fiber-reinforced ceramics have improved fracture toughness and damage tolerance compared to conventional ceramics and therefore they open up new fields of application as a construction material. One possible manufacturing method for silicon carbide-based fiber-reinforced ceramics is the liquid silicon infiltration (LSI) process, which is characterized by a three-stage process. In the first production step, a carbon fiber reinforced plastic (CFRP) is produced from a polymer with a high carbon yield (carbon precursor). During the subsequent pyrolysis, the matrix polymer is thermally converted to carbon. The resulting matrix shrinkage leads to the formation of a crack network. The result of the second production step is a porous carbon fiber-reinforced carbon (C/C). In the third production step, liquid silicon is infiltrated into the crack network. Silicon carbide is formed on the crack walls as a result of the reaction with the carbon. The end product is a heterogeneous material (C/C-SiC) with carbon fibers as a reinforcing component and a C-SiC dual-phase matrix.

In particular, the starting polymer that is used determines the associated shaping technology and influences over all process steps the structure and therefore the property profile of the final composite. Usually thermoset resins, such as phenolic resins, are processed. Whereas, the use of thermoplastics enables the use of large-scale and fully automated production technologies. Polyethylene is cost-effective and has good availability and processability. Additional stabilization, e.g. through thermal oxidation, enables a significant increase in the carbon yield. The aim of the student project is to investigate the suitability of different classes of polyethylene for the liquid silicon infiltration process. Process-structure-property relationships are to be identified and discussed.

Work to be carried out:

- Literature research on the state of the art
- Material selection and development of a test program
- Investigation of the stabilization process (thermal analysis, thermal treatment, etc.)
- Investigation of the pyrolysis process (thermal analysis, thermal treatment, etc.)
- Compound production using a measuring kneader and test specimen production using micro injection molding
- Stabilization, pyrolysis and silicon infiltration of the test specimens
- Characterization of the test specimens (porosity, microstructure, mechanical properties, etc.)
- Discussion of the results
- Summary and outlook



Fracture surface of a C/C composite

Requirements:

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

The work should be completed as a research project. Please send your CV and current transcript of records by email to **Shaun-george.antony@mb.tu-chemnitz.de** by **10 December 2025**.

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

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