MULTICRITERIA OPTIMIZATION AS ENABLER FOR SUSTAINABLE CERAMIC MATRIX COMPOSITES

Dietmar Koch, University of Augsburg, Institute of Materials Resource Management, Germany
Tobias Schneider, University of Augsburg, Institute of Materials Resource Management, Germany
Lars Wietschel, University of Augsburg, Institute of Materials Resource Management, Germany
Andrea Thorenz, University of Augsburg, Institute of Materials Resource Management, Germany

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During the last 40 years, development activities on Ceramic Matrix Composites (CMC) focused mainly on material improvement and optimizing cost-efficient processes. Recently, more fields of application have opened up for CMC, in which environmental impacts are relevant. These impacts have been barely investigated so far but receive growing interest due to increasing awareness of the environmental consequences.
Our innovative approach sets material properties in relation to environmental impacts (e.g., Global Warming Potential in CO_2 emission) under varying process parameters. This results in tradeoffs between material properties and environmental impacts. First, the wet filament winding process of a C/C-SiC material has been investigated up to the CFRP state by changing curing and tempering temperatures. During the production of CFRP plates, mass and energy flows have been tracked in each step. Three point-bending and interlaminar shear tests have been performed to identify basic mechanical properties. The environmental impacts are determined by a gate-to-gate Life Cycle Assessment (LCA) using SimaPro.

The resulting tradeoffs between mechanical properties and environmental impacts show nonlinear behavior, thus revealing breakpoints above which improved mechanical properties are associated with significantly higher CO_2 emissions. This work is a first step leading to the design of “Sustainable Ceramic Matrix Composites” (SCMC).