Silesian University of Technology
Faculty of Mechanical Engineering
Scientific and Didactic Laboratory of Nanotechnology and Materials Technologies

ALUMINIUM MATRIX COMPOSITE MATERIALS REINFORCED BY CERAMIC PREFORMS MANUFACTURED BY FDM METHOD

Marek Kremzer, Błażej Tomiczek

Abstract

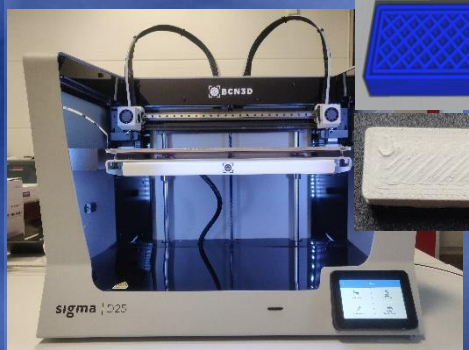
The achieved research goal presented in the competition application directly fits into the current research trends and The achieved research goal presented in the competition application directly fits the current research trends and responds to the market demand for developing modern, near-net shape composite materials. The subject of the presented solution is the use of FDM printing to produce ceramic skeletons of a complex shape intended for pressure infiltration with liquid metal or alloy.

Pressure infiltration as a highly cost-effective manufacturing technology of composite materials has many advantages, including the possibility of obtaining "near net shape" products with accurate shape mapping and high surface quality and the opportunity of their local reinforcing. Furthermore, such technology significantly reduces or eliminates the need of finishing. Unfortunately, such products are only possible to obtain during infiltration in a matrix or free infiltration when the shape and size of the metal-penetrated ceramic framework correspond to the geometry of the final product. However, the situation becomes more complicated in the case of the production of elements with a complex shape because conventional porous frameworks are most often produced by uniaxial pressing and sintering of ceramic powders, which significantly reduce the complexity of their shape. In addition, each change in the geometry of the manufactured element requires the design and manufacture of a new matrix, affecting this method's low flexibility. Due to the above limitations, it is advisable to use the additive manufacturing technology of porous ceramic frameworks, which allows for their pressure infiltration with liquid metal or alloy at a later stage.

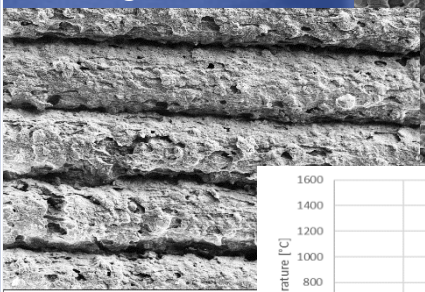
An unquestionable advantage of this solution is the possibility of designing the proportion of pores, their size and shape. Furthermore, thanks to the combination of additive manufacturing technology and liquid metal infiltration, it is possible to produce cermets with a precisely designed structure, which can be homogeneous or gradient. In addition, it is possible to create components with complex shapes.

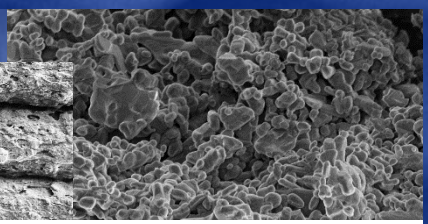
Acknowledgment: Research supported as part of the Excellence Initiative - Research University program implemented at the Silesian University of Technology in 2023

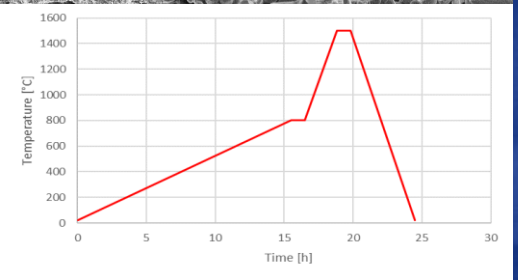
3D printing



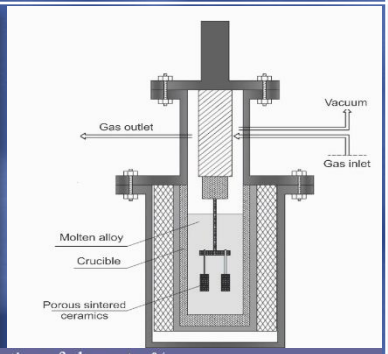
Sintering







Pressure infiltration



Mean mass concentration of elements, %

Si	Fe	Cu	Mn	Zn	Ti	Others		Al
						Each	Together	
10.5-13.5	≤0.55	≤0.05	≤0.35	≤0.10	≤0.15	≤0.05	≤0.15	The Others

Microstructure