Pellets Additive Manufacturing for complex shaped silicon carbide ceramics

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In the aerospace and energy sector, materials with high thermal conductivity, chemical stability and good thermal shock resistance, a low coefficient of thermal expansion combined with a high specific strength are indispensable. Silicon carbide (SiC) ceramics are predestined for demanding applications like heat exchangers, propulsion systems or lightweight structures for optical devices.

Since the machining of SiC is very complex and expensive, near-net-shape ceramic components are developed in order to reduce costs.

This required the development of a suitable thermoplastic raw material in order to produce a green body using an extrusion-based 3D printing process. For this purpose two different compound systems based on sacrificial and non-sacrificial thermoplastic binders have been developed. Both have been mixed with carbon fillers or SiC powder and processed into pellets. The shaping of the green body took place in the 3D printer Pellets Additive Manufacturing (PAM).

The polymeric green body could then successfully be converted into a dense ceramic part via the Liquid Silicon Infiltration (LSI) process. Common 3D printing processes for ceramic yield in high shrinkage rates which is in contrast to the aim of near-net-shaping. With the presented process the authors were able to reduce the shrinkage to less than 5%.

The converted samples have been analyzed via SEM images and mechanical tests.

It could be shown that it is possible to produce different kinds of microstructures with only one 3D printing process by setting the properties of the compound. This demonstrates the high potential 3D printing offers for the manufacturing of near-net-shape ceramic parts.