LITHOGRAPHIC 3D PRINTING OF CERAMICS, METALS, AND MULTIMATERIAL COMPONENTS

Martin Schwentenwein[a], Sebatian Geier[a], Gerald Mitteramskogler[b], Josef Schlacher[c], Raul Bermejo[c] and Johannes Homa[a]

[a]Lithoz GmbH, 1060 Vienna, Austria
[b]Incus GmbH, 1220 Vienna, Austria
[c]Department of Materials Science, Montanuniversität Leoben, 8700 Leoben, Austria

3D Printing or additive manufacturing (AM) of ceramics and metals using lithography-based techniques is getting more and more attention in recent times. Using this route it is possible to combine the high precision and flexibility of lithographic AM processes with the exceptional material properties of ceramics and metals and thus, opening a completely new field for photopolymerization-based AM.

High-performance ceramics show some unique properties in terms of mechanical properties as well as excellent wear and temperature resistance while metals provide electrical and thermal conductivity and usually highly ductile behaviour. Especially components made by lithographic AM exhibit high precision, low surface roughness and – because the approach goes via a conventional sintering route – the same basic microstructure as conventionally formed analogues. The resulting components are of competitive strength and quality as to conventional fabrication techniques and demonstrate the possibility to use photopolymerization as a means to structure high-performance materials beyond polymers.

In addition to these results on lithographically produced ceramic and metal components this contribution will also present first results in the direction of directly combining different materials during the shaping process to enable functionally-graded materials and multimaterial components to enable novel types of components. As example for such a multimaterial structure laminate designs of aluminum oxide (alumina) and zirconium oxide (zirconia) will be presented. Here, the effect of compressive residual stresses on the strength of such a multilayer system is investigated under biaxial bending tests and compared to 3D printed bulk material. A characteristic biaxial strength as high as 1 GPa was measured on the alumina-based multilayers, as compared to 650 MPa in bulk alumina. Thus, this work shows that designing complex-shaped multilayer architectures with tailored residual stresses through additive manufacturing technologies opens a new path for advanced ceramics with unprecedented mechanical behavior.