Powder particle density and distribution in injection moulded green metallic and ceramic micro parts

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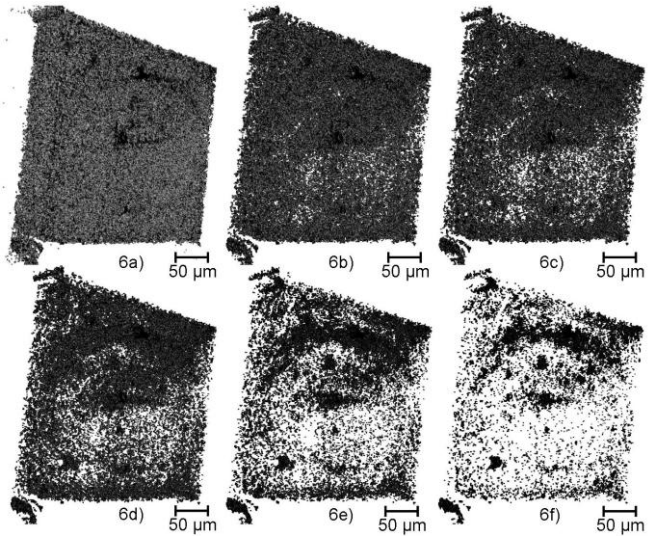
Powder injection moulding is one of the most promising replication methods for the mass production of metal and ceramic micro parts[1]. The material for injection moulding, a so-called feedstock, consists of thermoplastic binder components and inorganic filler with approximately equal volume fractions. Injection moulding of the feedstock leads to a green part that can be processed to a dense metal or ceramic micro part by debinding and sintering.
During the injection moulding process extremely high shear rates are applied. This promotes the separation of powder and binder leading to a particle density variation in the green part causing anisotropic shrinkage during post-processing. The knowledge of introducing density gradients and defects would consequently allow the optimization of the feedstock, the moulding parameters and the validation of a simulation tool based on the Dissipative Particle Dynamics (DPD) which is currently under development, as well.
To determine the particle density and defect distribution in micro parts synchrotron radiation tomography in absorption mode was used. Due to its parallel and monochromatic character a quantitative reconstruction, free of beam hardening artifacts, is possible[2]. For the measurement, bending bars consisting of dispersed fused silica particles in a polymeric matrix were used. The experiments show that particle agglomerates and density variations in the micrometer range can be resolved. Additionally, various defects influencing the mechanical properties in the sintered state like flashes, disruptions or edge rounding in submillimeter sized green parts can be detected with this method[3]. These regions are of special interest regarding powder particle distribution in the binder material. The influence of process parameters on the flow behaviour of feedstock systems in micro dimensions will be the centre of further research. For better trade between contrast and photon transmission and resolution, different powder materials with selectable particle sizes or other tomography modes like phase contrast will be used.



Section of a measured micro bending bar (thickness: 55µm).

1. German, R.M. et al., Princeton, N.J.: Metal Powder Industries Federation (1997).
2. Salvo, L., et al., Nucl. Instr. and Meth. B, 200 (2003): p. 273-286.
3. Heldele, R., et al., Nucl. Instr. and Meth. B, 246(1) (2006) p. 211-216.