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Quantitative Study of Shear Induced Particle Migration during Micro Powder Injection Moulding

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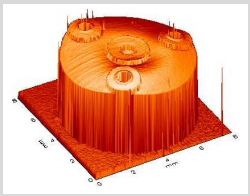
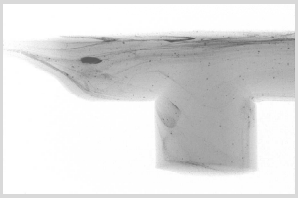
Powder injection moulding provides an opportunity to produce complexly shaped micro components of ceramic or metal. One of the biggest challenges of µ-PIM is to produce non-deforming, dimensionally stable components. Due to the multi-phase character of the feedstock separation effects between powder and binder matrix can occur during the moulding, which have an essential influence on the quality of the green parts and therefore on the dimensional and mechanical properties of the final parts. The main objective of this study is to investigate the effect of the powder particle distribution in injection moulded green micro parts with respect to the moulding parameters using synchrotron-CT and 3D-image evaluation.

Motivation

Prevention of inhomogeneous particle distribution

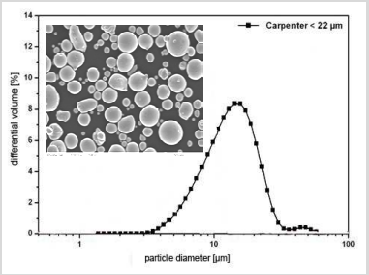


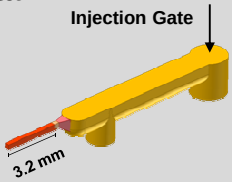
Deformation after debinding and sintering



Flow lines in green parts

Experimental



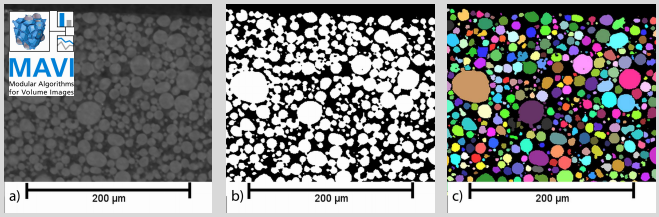


Powder characteristics (**left**) and flexural micro-specimen cross section 260 x 260 µm (**right**)

Plunger velocity	Shear Rate
500 mm/s	$1.5*10^5$ s^{-1}
50 mm/s	$1.5*10^4$ s^{-1}

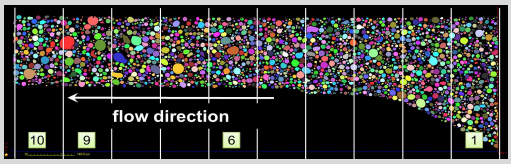
Table 1.: Estimated calculation of shear rates

Image processing using MAVI



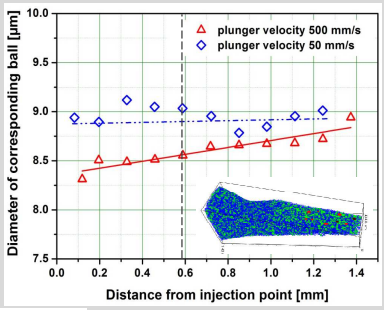
a) example slice taken from the gray-scale volume images
b) corresponding binarized image of the powder particles
c) separated and individually labeled particles

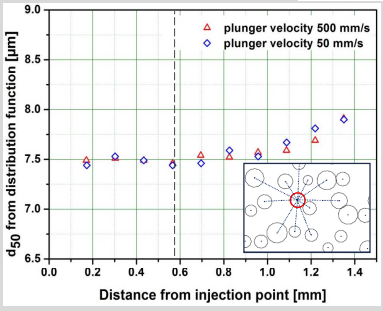
Results of image analysis



Top: Longitudinal section along the flexural micro-specimen indicating the analyzed ten stacks (130 µm/stack)

Right: Spatially resolved particle size distributions





Left: Point process statistics using nearest-neighbor distance distribution function *G(r):* spatial arrangement of the particles

Conclusion

The results showed that the variations in the size distribution of the metal powder particles can be detected and give consistent evidence for a monotonic increase in particle size with distance to the injection gate. Current work is focused on consideration of further methods from spatial statistics and of local particle density distributions along flow direction as well as over cross section.

See also: J.Mater.Sci.(2011) 46:3568–3573; DOI 10.1007/s10853-011-5270-9

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