Karlsruher Institut für Technologie

Manufacturing and Investigation of Precision Powder Injection Moulded Parts

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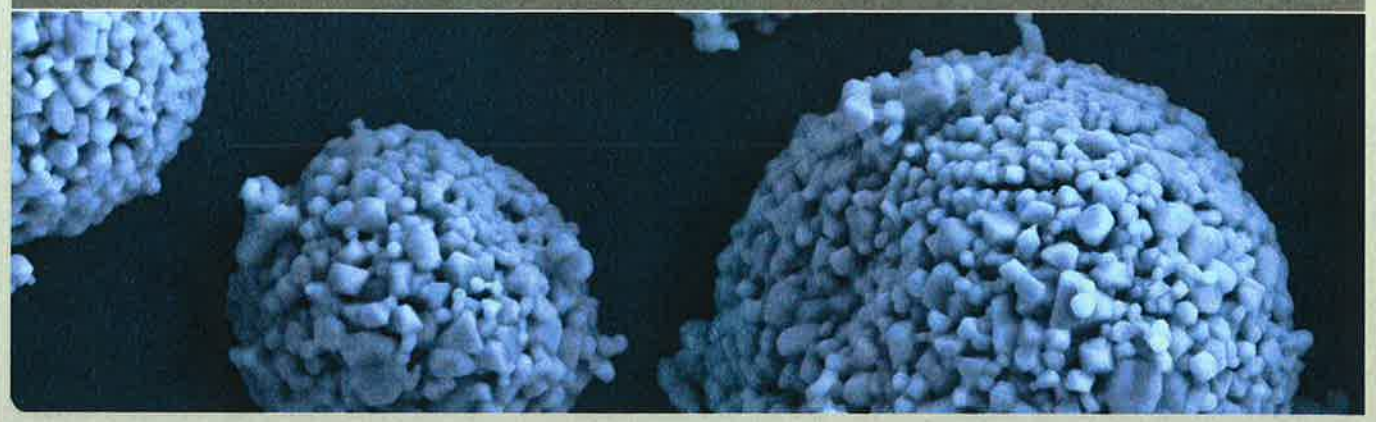
INSTITUTE FOR APPLIED MATERIALS - (IAM – WK)



KIT – Universität des Landes Baden-Württemberg und
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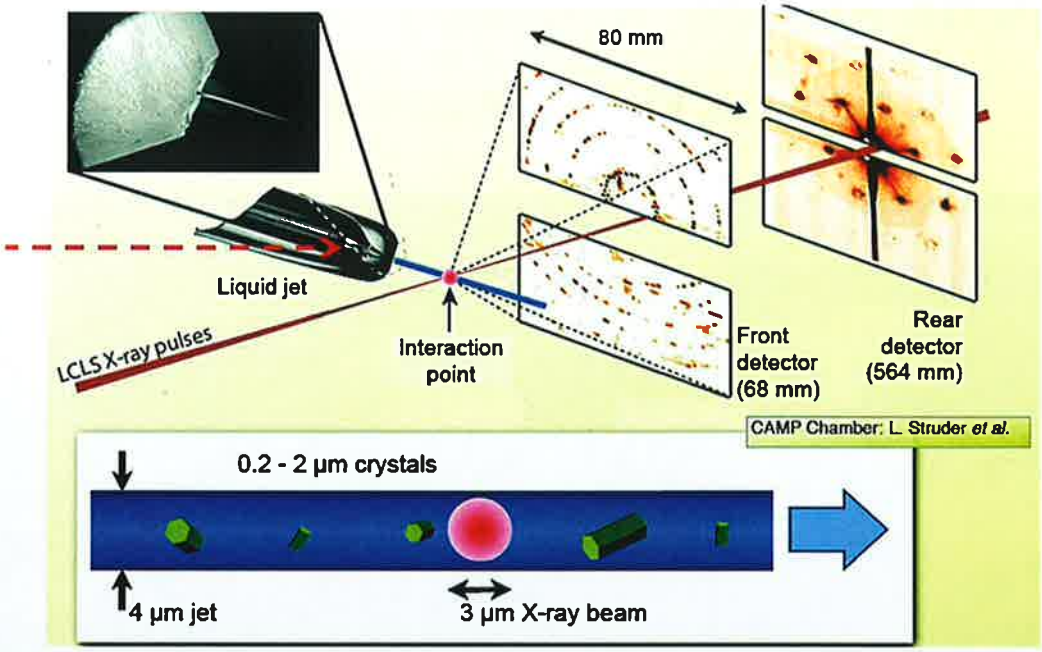
Contents

- Precision and Micro Powder Injection Moulding - an Example
- Accuracy considerations on PIM
- Opportunities for increased accuracy
- Outlook

Precision Ceramic Capillaries

Liquid Jet Nozzles for European X-ray Free Electron Laser

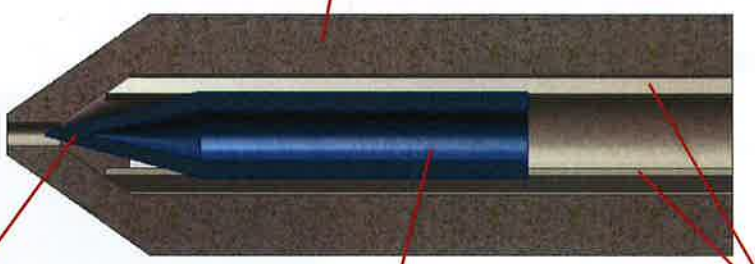
Collaborative project between DESY-CFEL and KIT-IAM

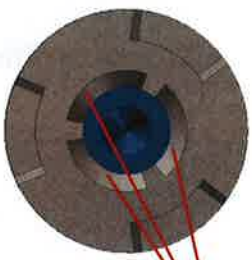


Current Design

outer-Ø = 1,56 mm
inner-Ø = 0,8 mm

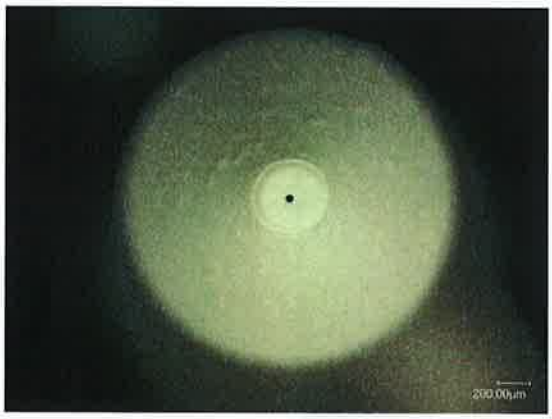
isometric view



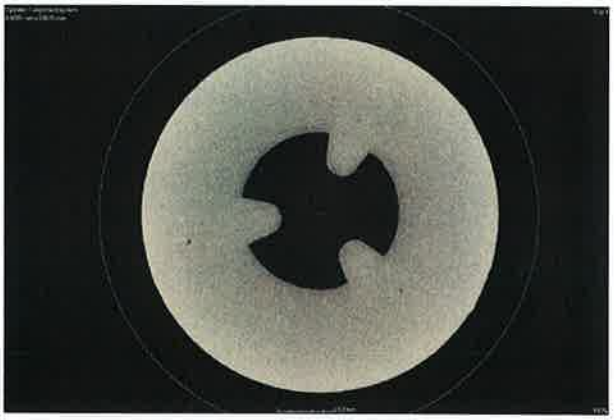


Simulation

First Results



Front view of ceramic capillary
Ø = 40 µm



CT cross section image
with internal guide bars

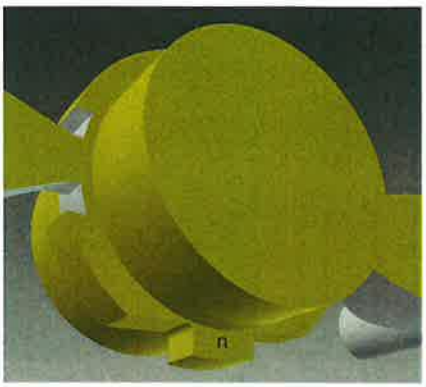
Current precision of CIM parts: ± 0.3%

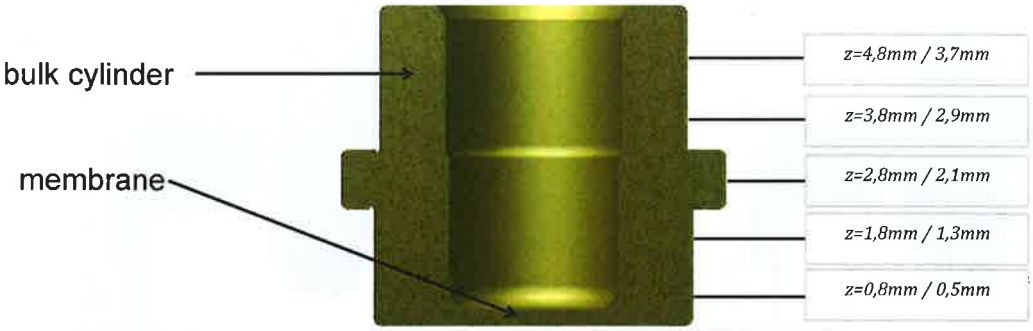
Might be much better for a few particular dimensions

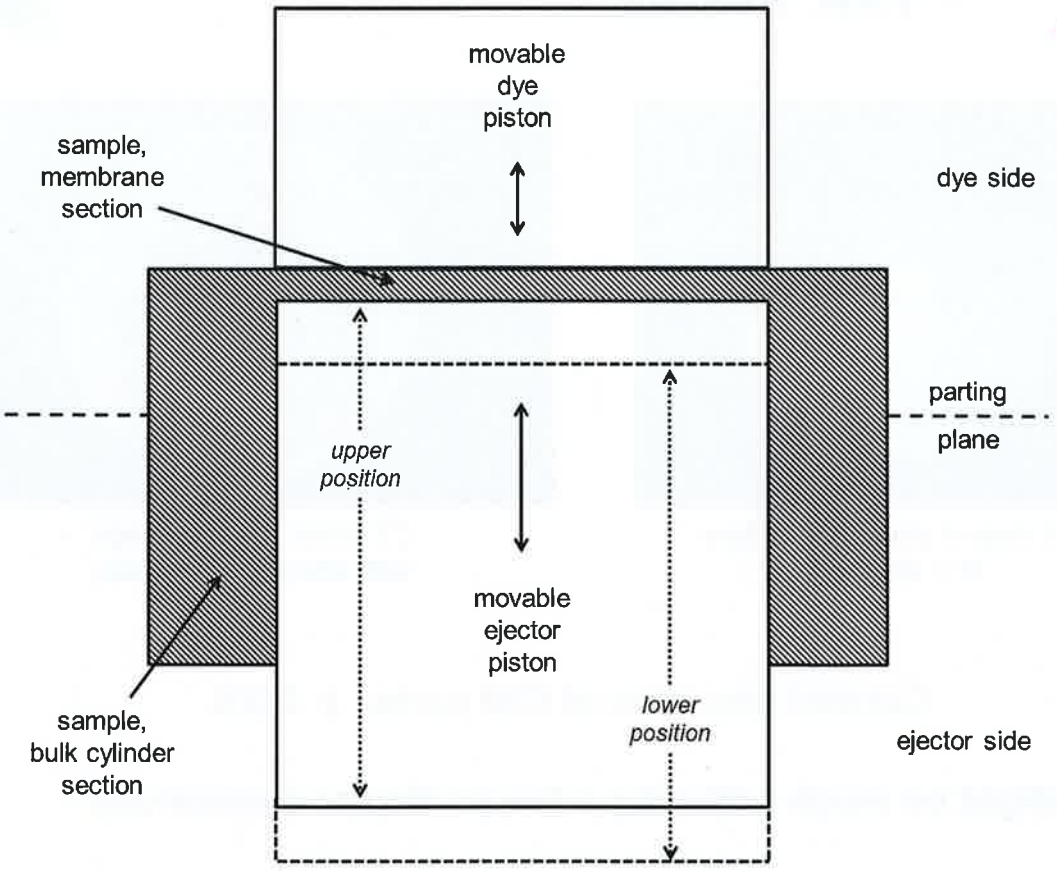
How to Improve PIM Accuracy

Creation of demonstrator:

Membrane carrier







Process conduct

2-step Process: Feedstock injection + embossing

» *pull back the pistons*

» *filling this cavity by injection of feedstock*

» *push the pistons forward up to final membrane thickness*

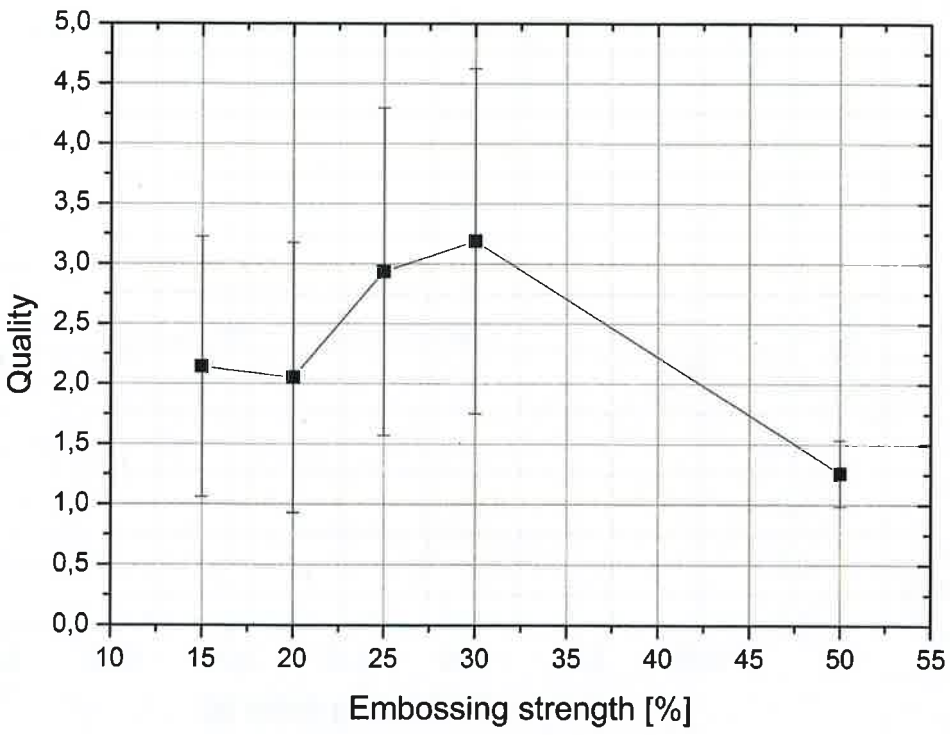
Variation of main parameters:

embossing force

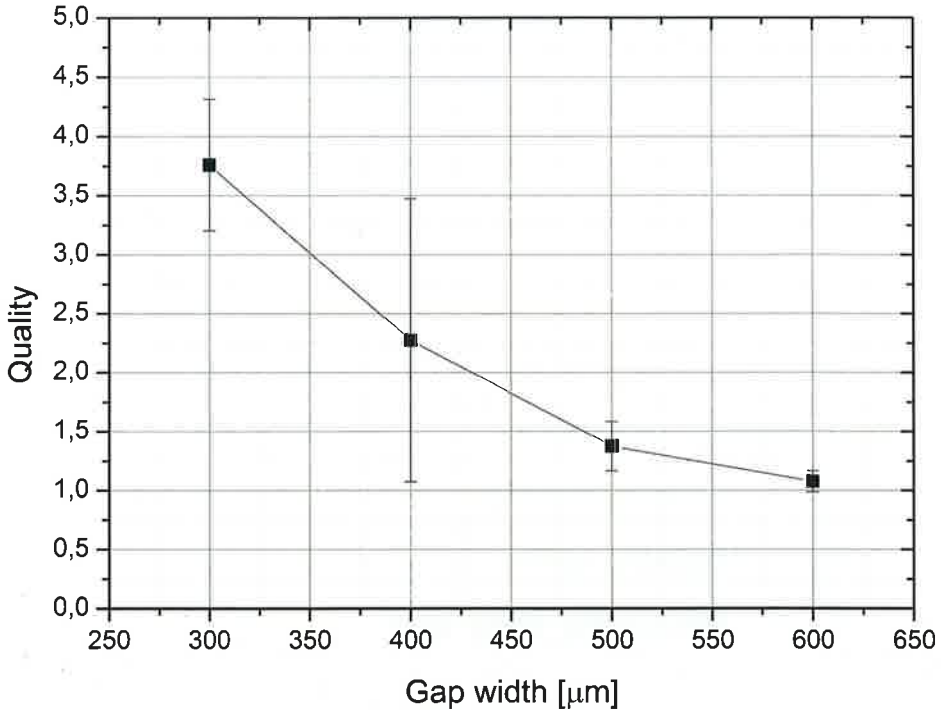
opening width

embossing delay time

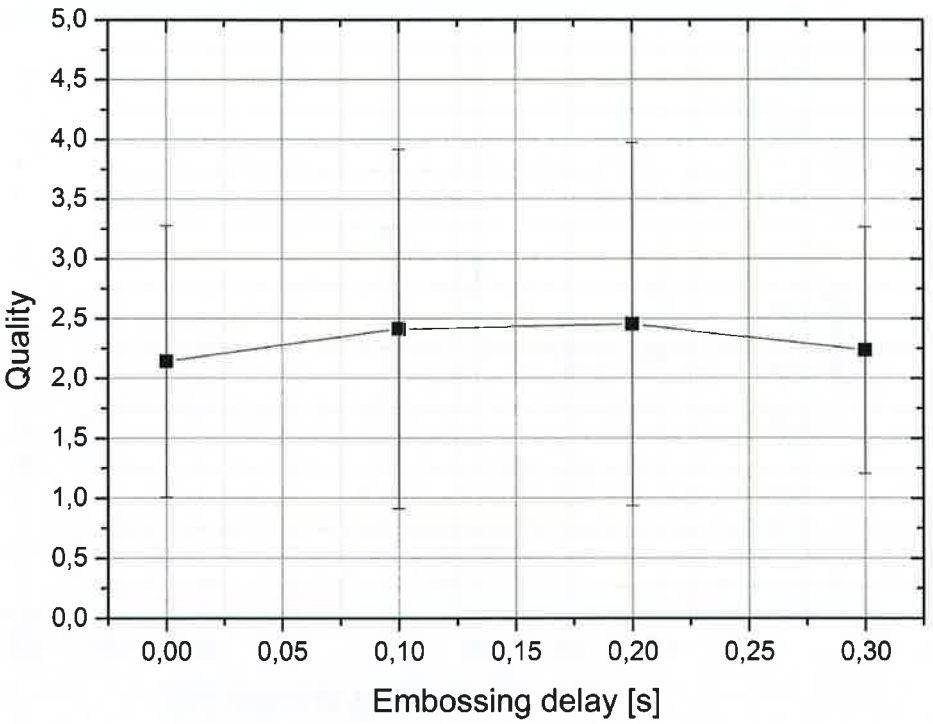
Embossing Force



Opening Width

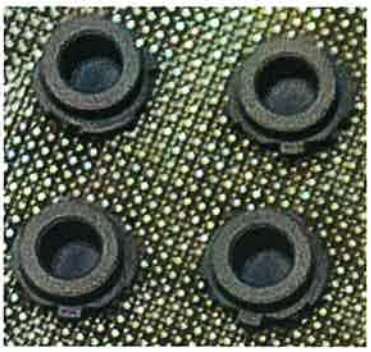


Embossing Delay Time

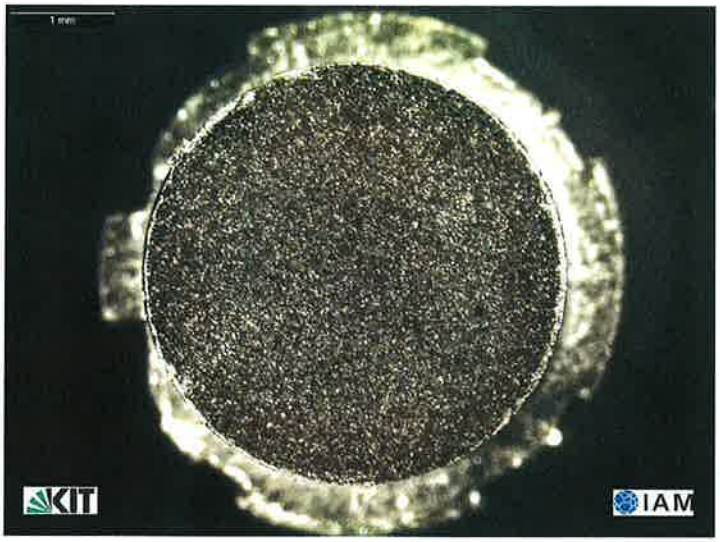


Sintered Specimen

membrane carriers before debinding



membran sample after sintering

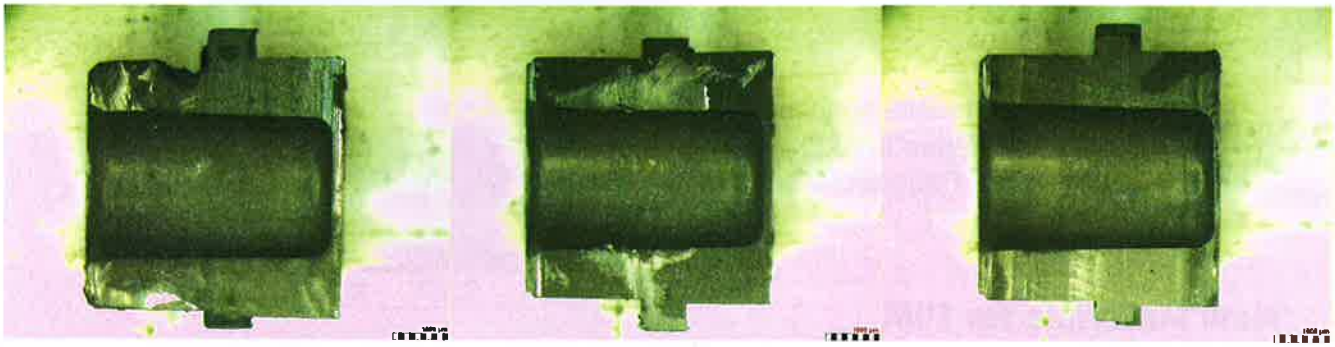


Constancy density
< ± 0.2%

Constancy membrane thickness
± 0.4%

Minimum membrane thickness
≤ 200µm

Further reduction of membrane thickness



200µm 150µm 100µm

Sintered sample
thickness ca. 90µm
feedstock sticks on piston top

Outlook

Accuracy of PIM

- investigation of bimodal powders
- reduced shear rates, variothermal temperization

Simulation of PIM

- jetting, powder-binder segregation etc.
- simulation of embossing step ↔ powder pressing

PIM Materials

- water soluble binder systems

  (PEG/PMMA or PVB/PMMA)

Outlook

Sintered tensile specimen
10% Nextel fibers in Al_2O_3 matrix
(Source: M. Tülümen, IAM-WK)

New Materials for PIM

- Ceramic Matrix Composites (CMC)
- High Entropy Alloys (HEA)

sintered Co20Cr20Fe20Mn20Ni20 alloy
density approx. 7.65g/cm³

Acknowledgment

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Thank you !