Karlsruher Institut für Technologie

Accuracy Examinations in Powder Injection Compression Moulding

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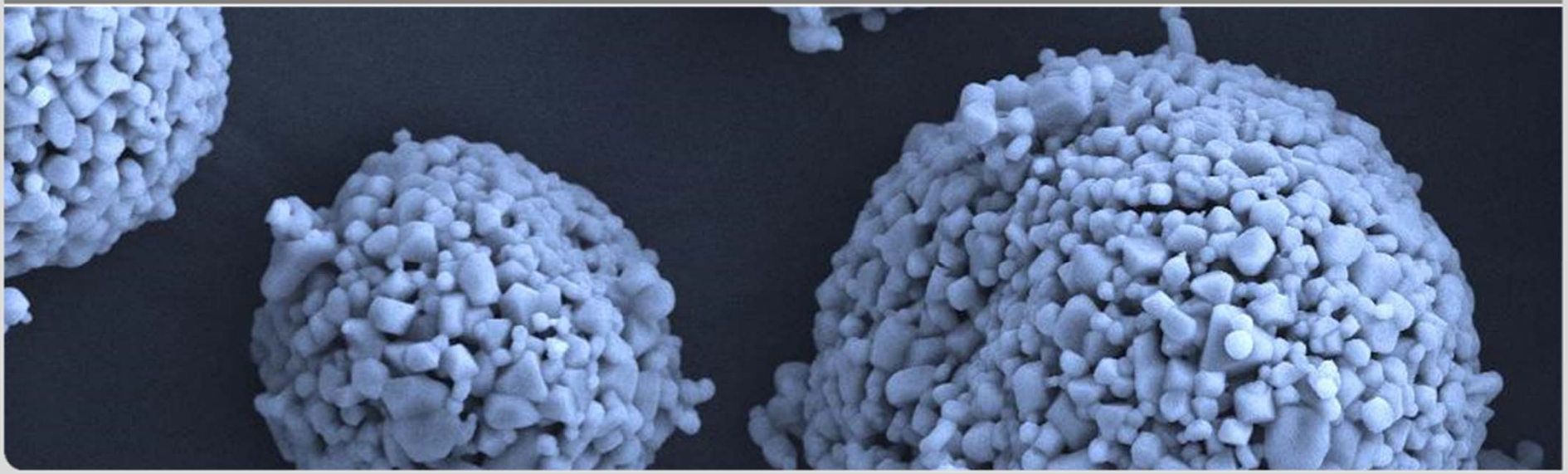
INSTITUTE FOR APPLIED MATERIALS - (IAM – WK)



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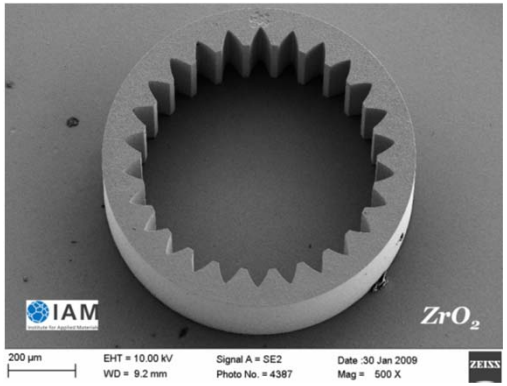
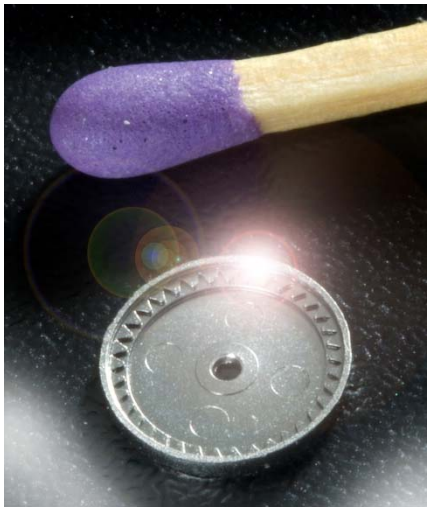


- PIM Accuracy: Powder loading
- Thickness variations: Demonstrator
- Minimum membrane thickness
- Accuracy investigations
- Outlook



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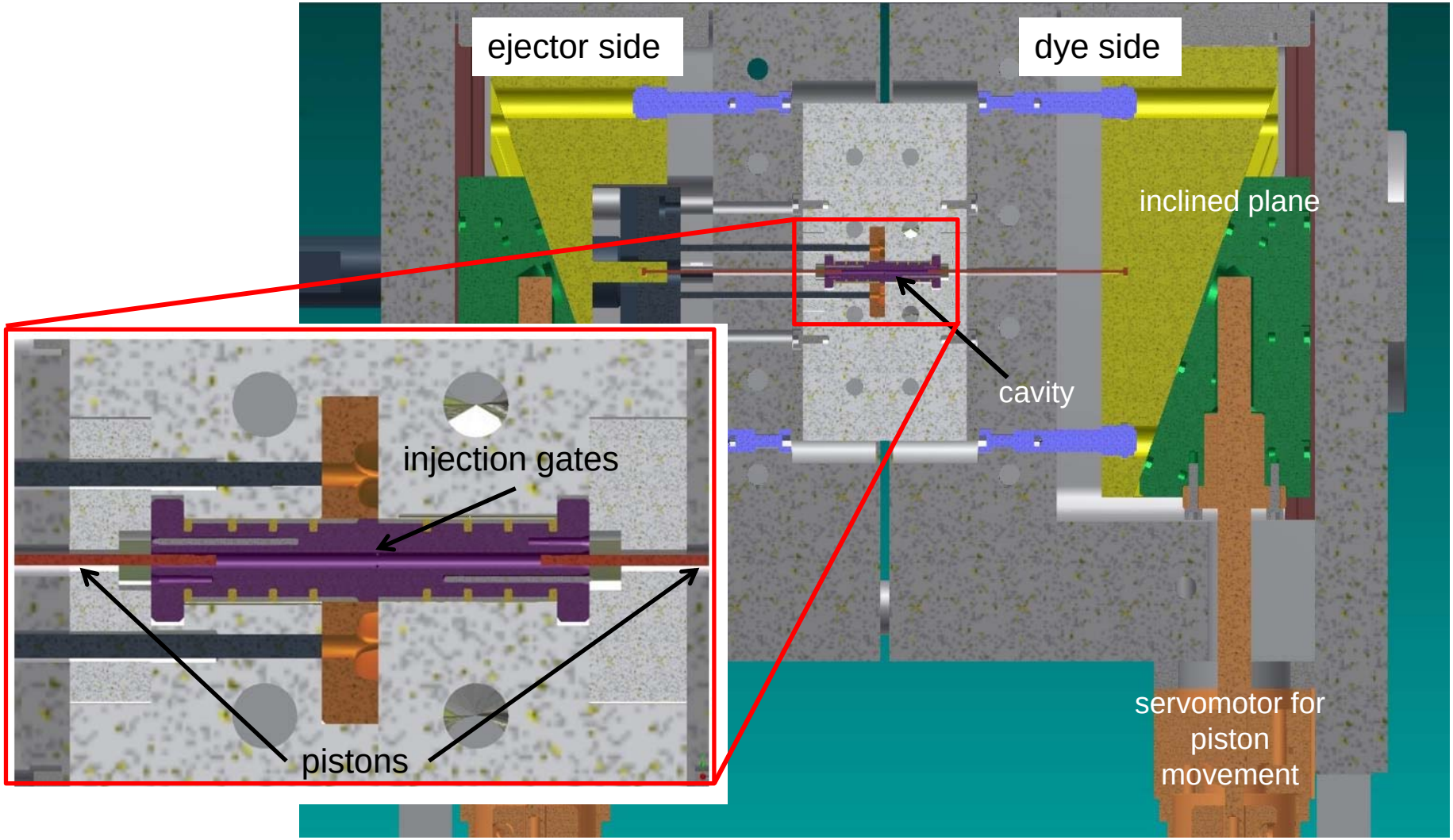
Scheme of twin-piston tool



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PIM Accuracy

First demonstrator:

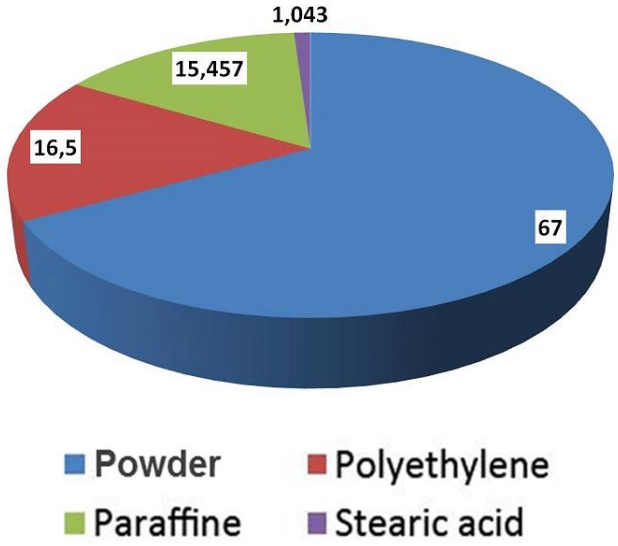
Cylinder Ø = 2.015mm

measuring positions

gate position: dye side / middle

piston pressure: 5.8% / 19.5% of $P_{max, motor}$

Feedstocks:



Powder: 17-4PH Osprey 1.4542

D_{50} ca. 4µm

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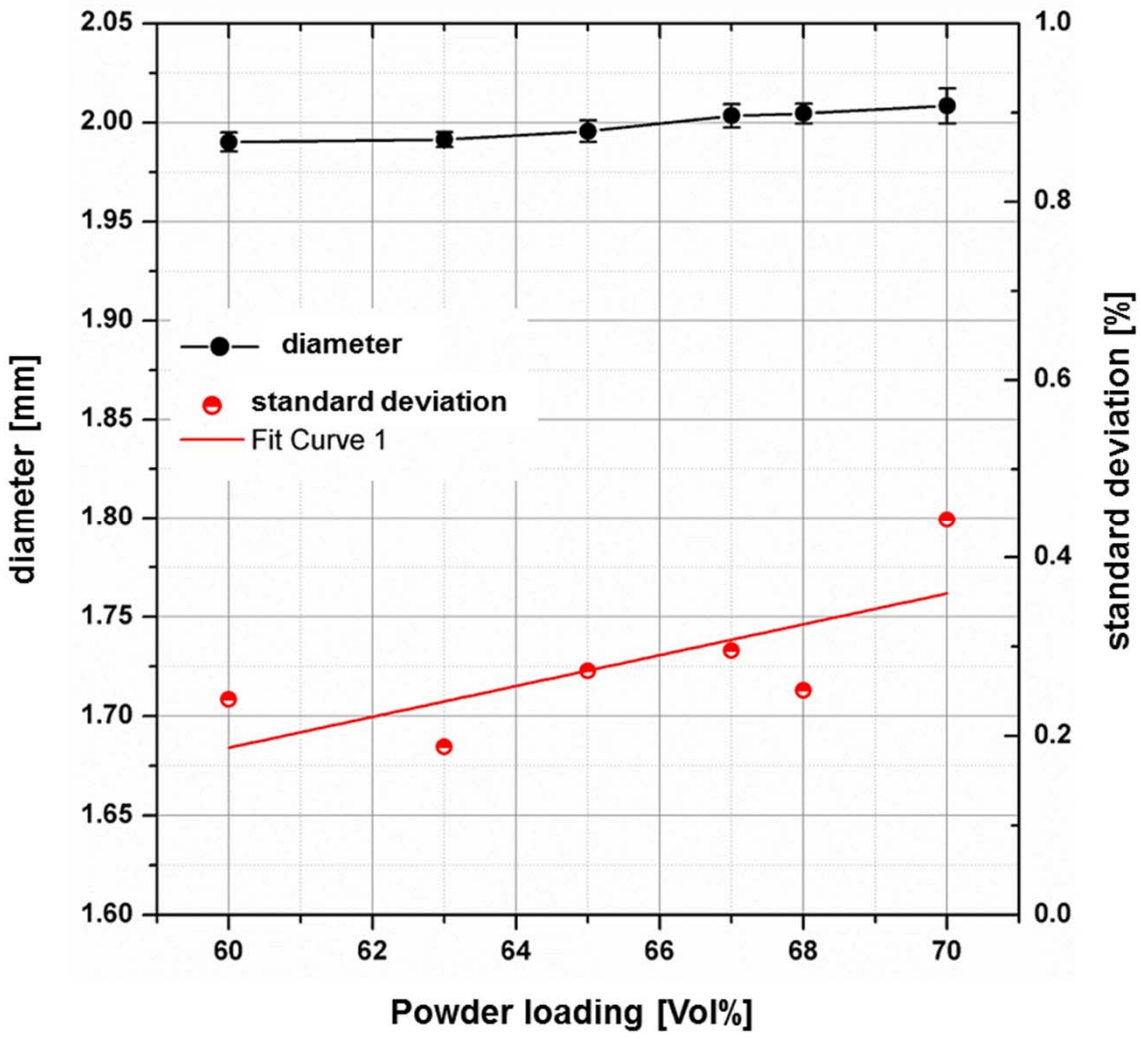
PIM Accuracy

Green bodies



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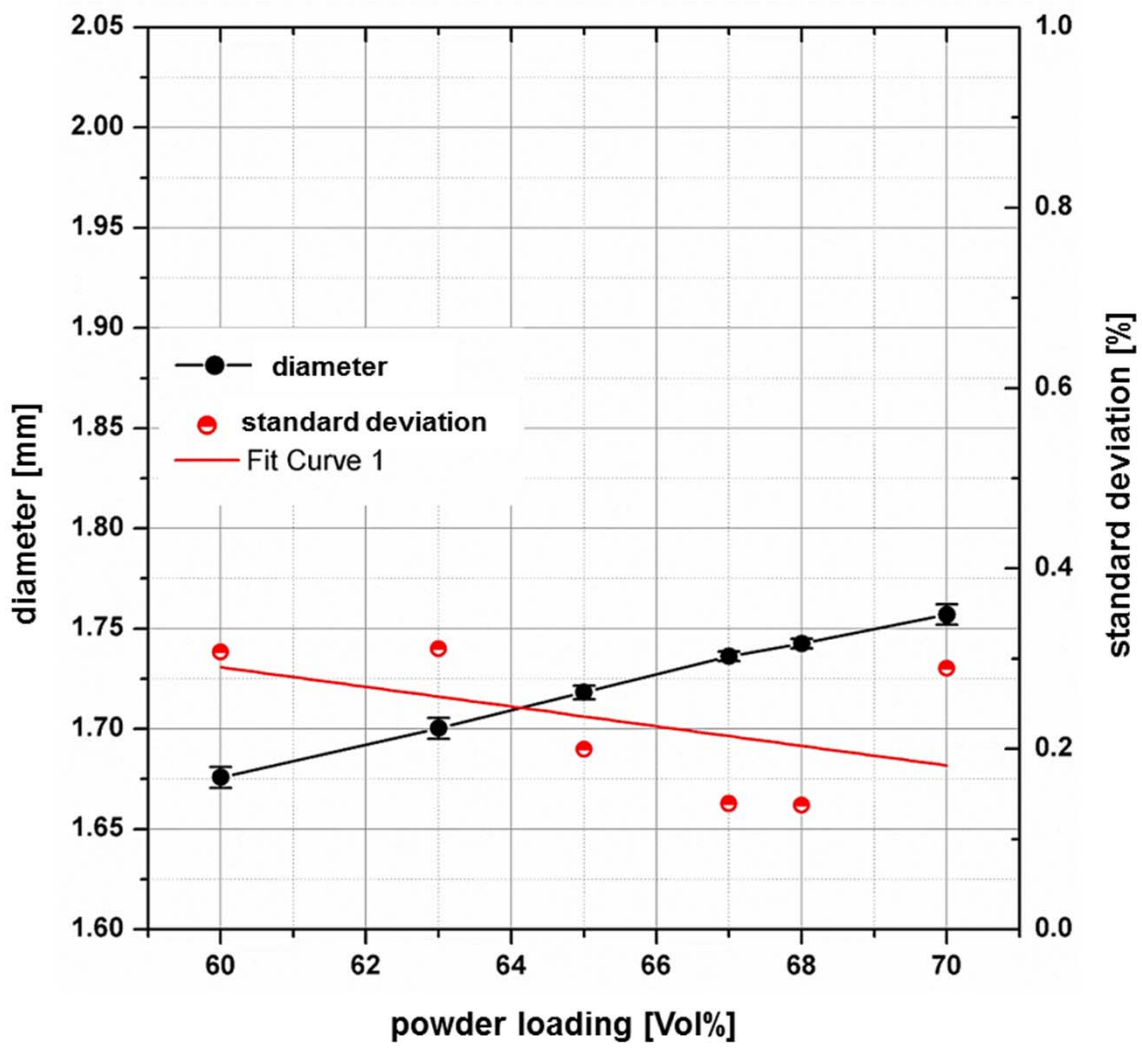
PIM Accuracy

Sintered parts



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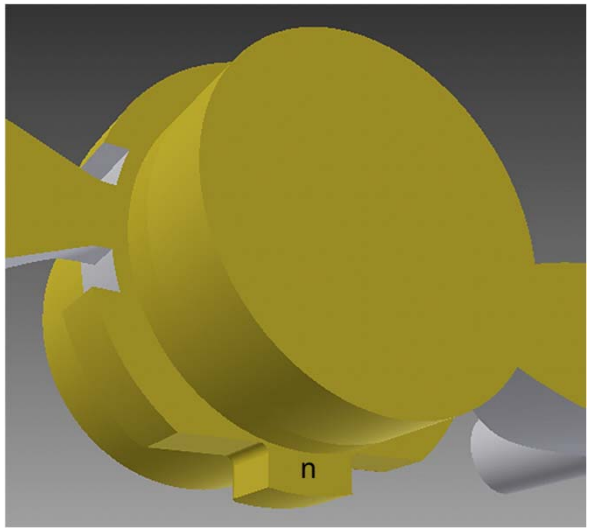
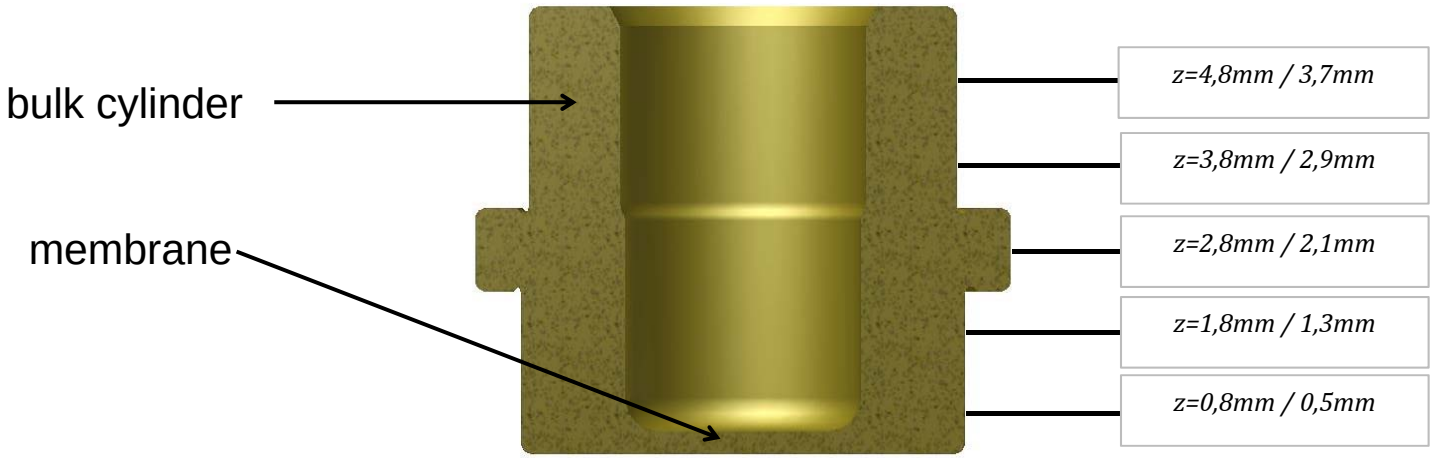
Parts with considerable thickness variation

Creation of demonstrator:

Membrane carrier





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Process conduct

Process 1: Unaltered powder injection moulding

- 63Vol% 17-4PH feedstock
- filling simulations
- constancy of cylinder diameter

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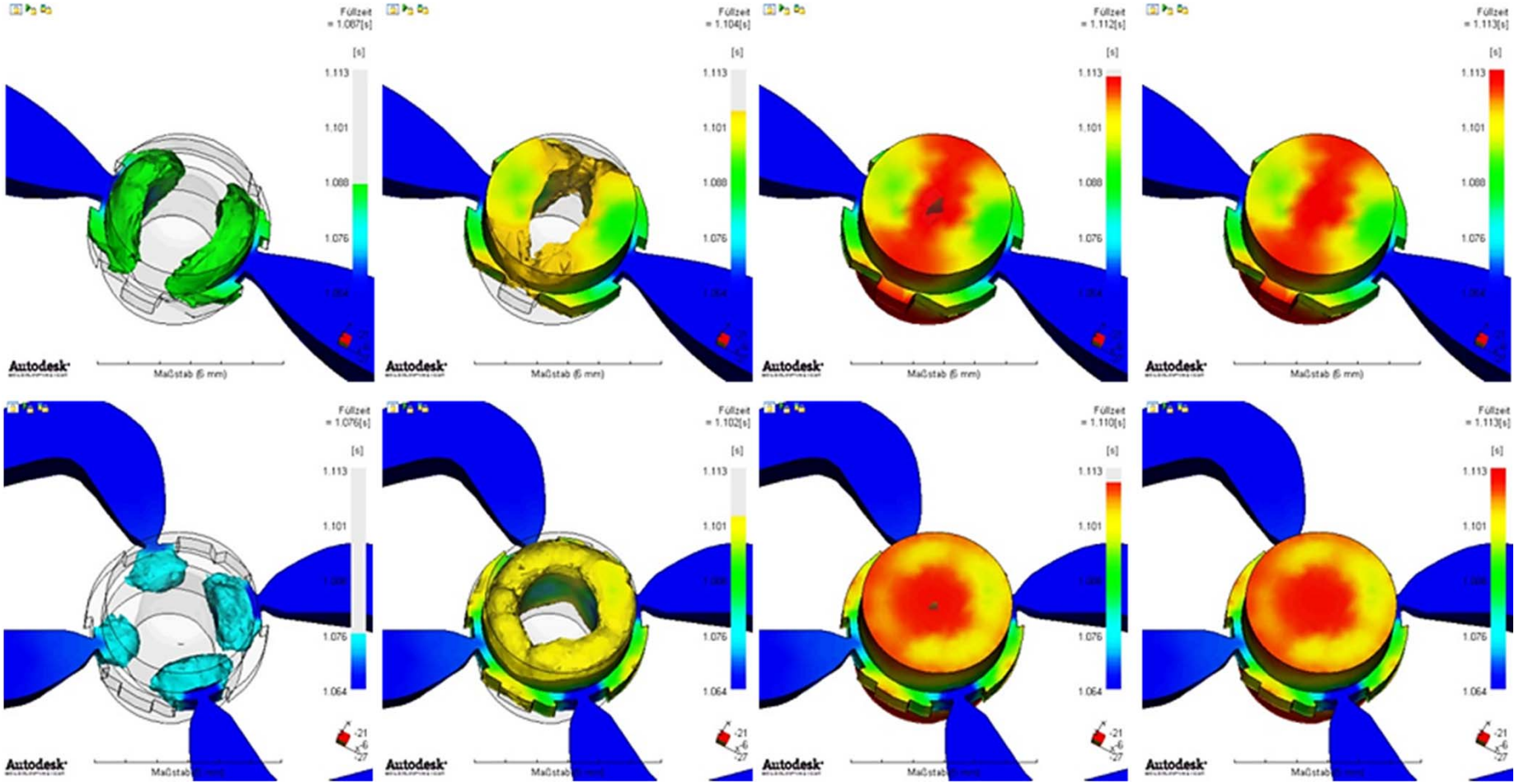
Filling simulation

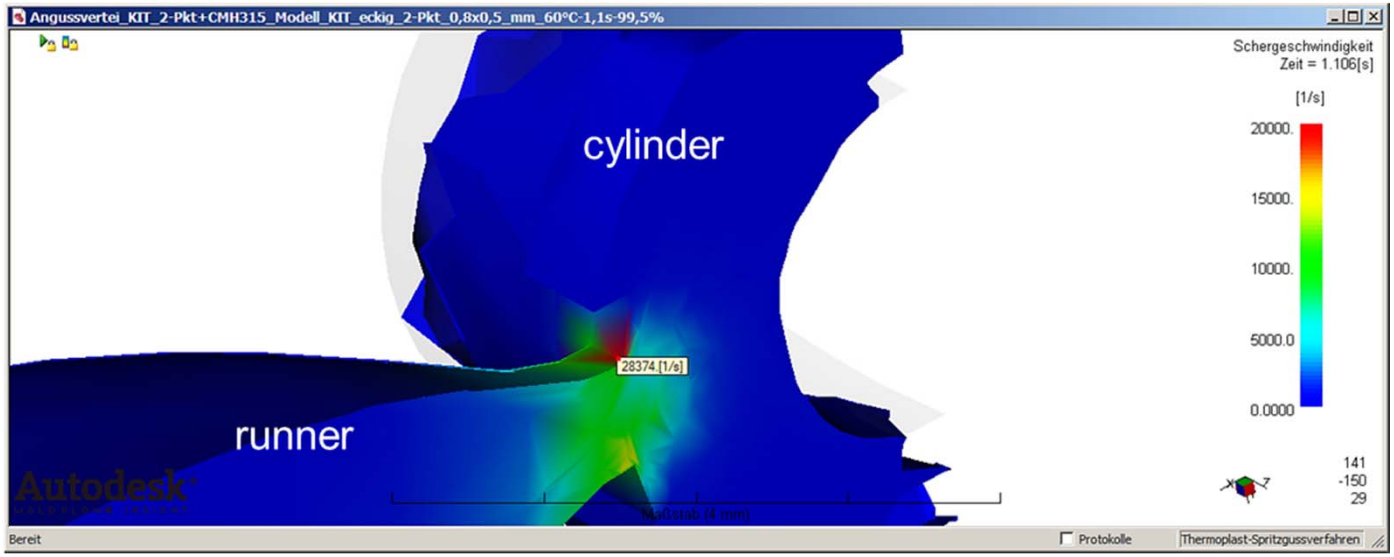
Evaluation of most suitable runner system

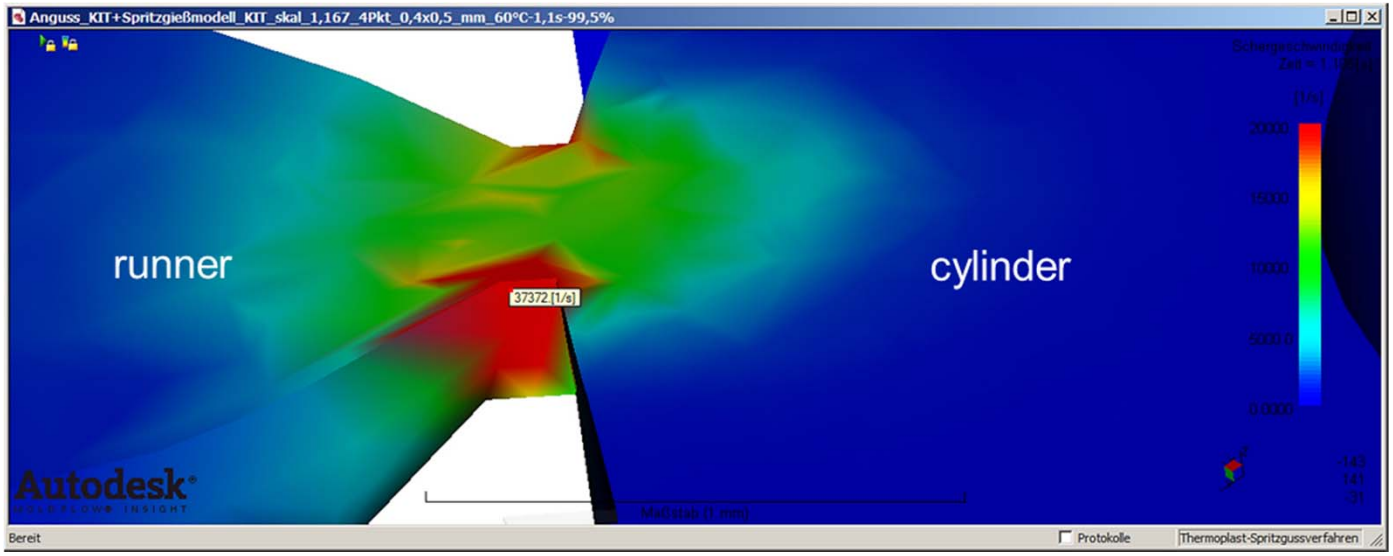


verified by short-shot studies

Filling simulation

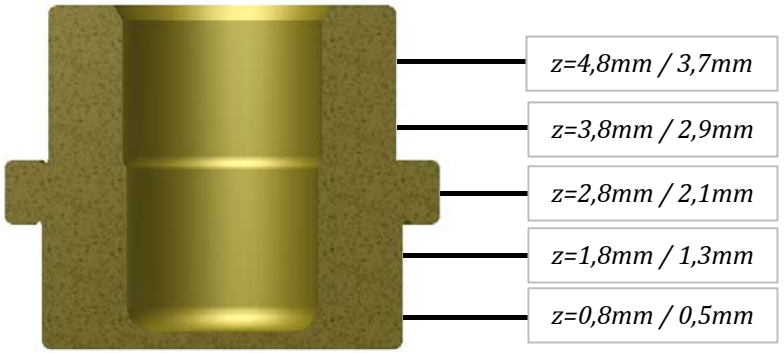
determination of critical shear rates

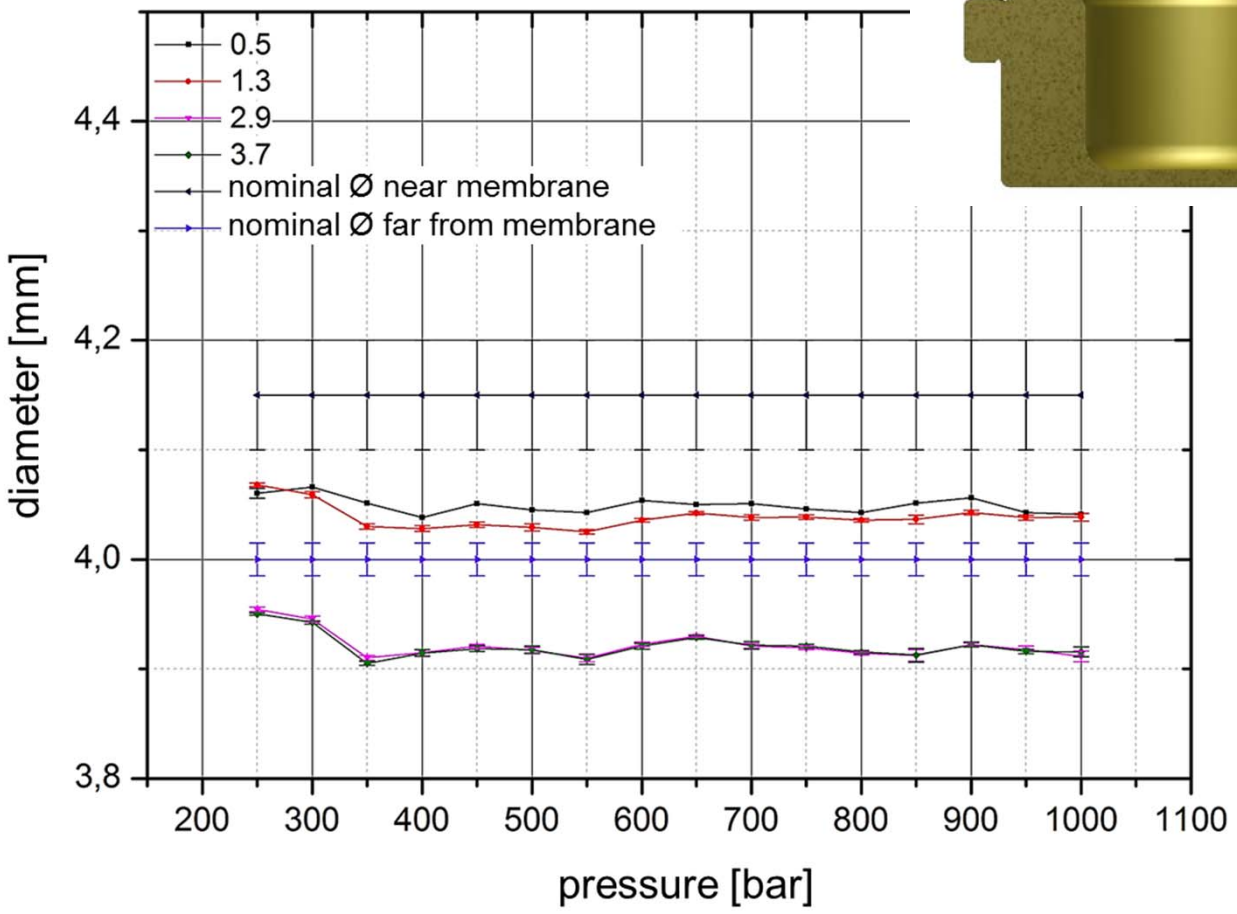




→ acceptable shear rates

Accuracy of unaltered PIM





Variance of cylinder diameter

ca. ± 0.15%

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Process conduct

Process 1: Unaltered powder injection moulding

- 63Vol% 17-4PH feedstock
- filling simulations
- constancy of cylinder diameter ca. ± 0.15%
- minimum membrane thickness ca. 400µm

Process 2: Powder injection moulding + embossing step

» *pull back the pistons*
» *filling this cavity by injection of feedstock*
» *push the pistons forward up to final membrane thickness*

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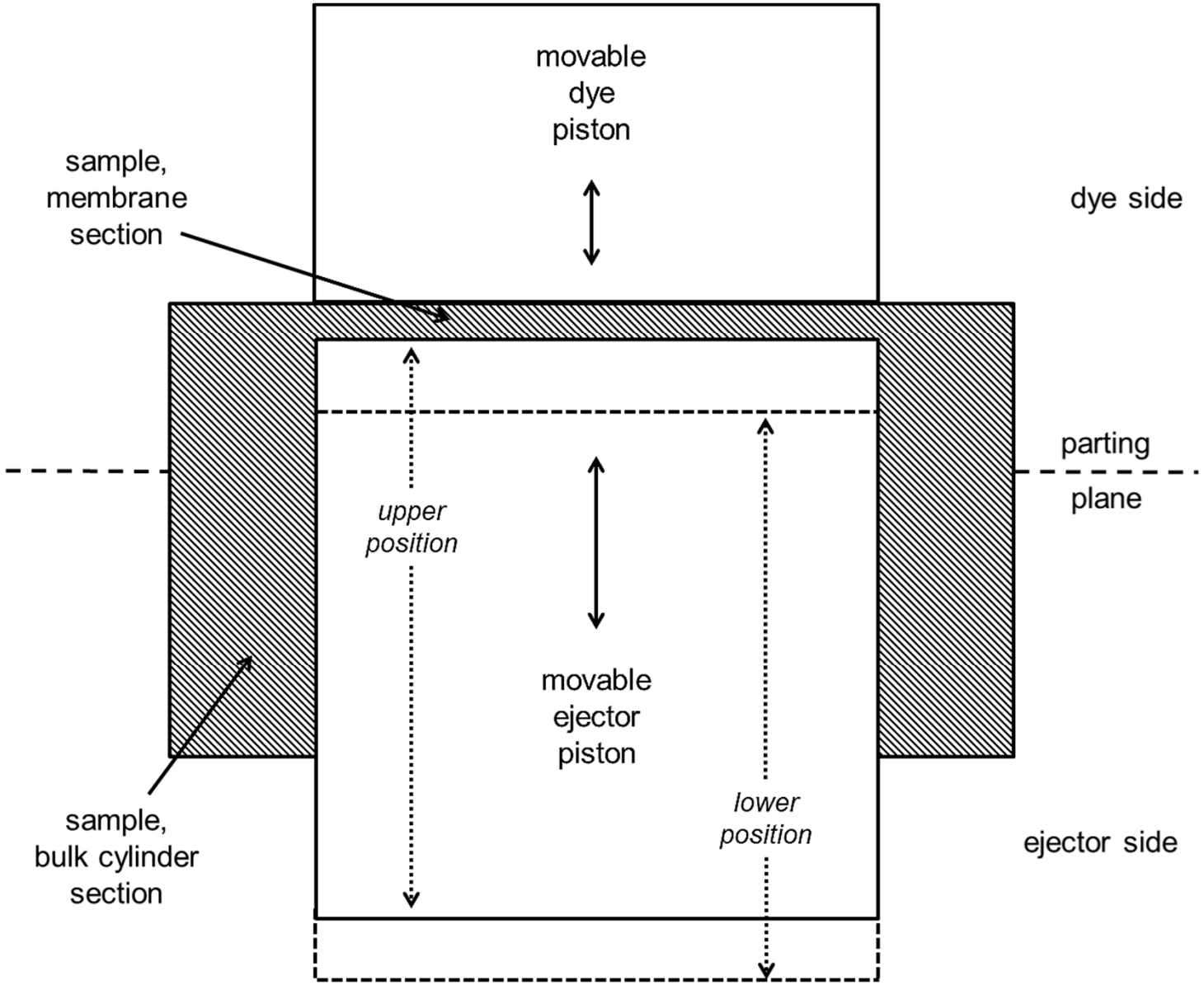

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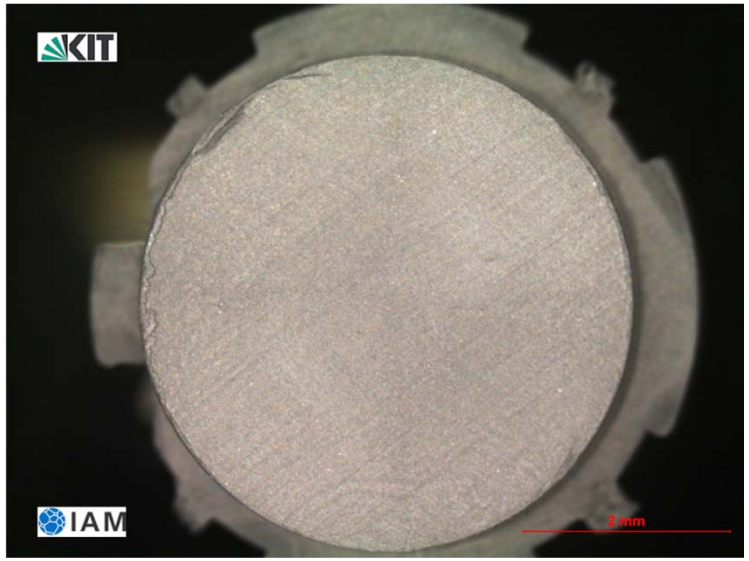
Minimum membrane thickness

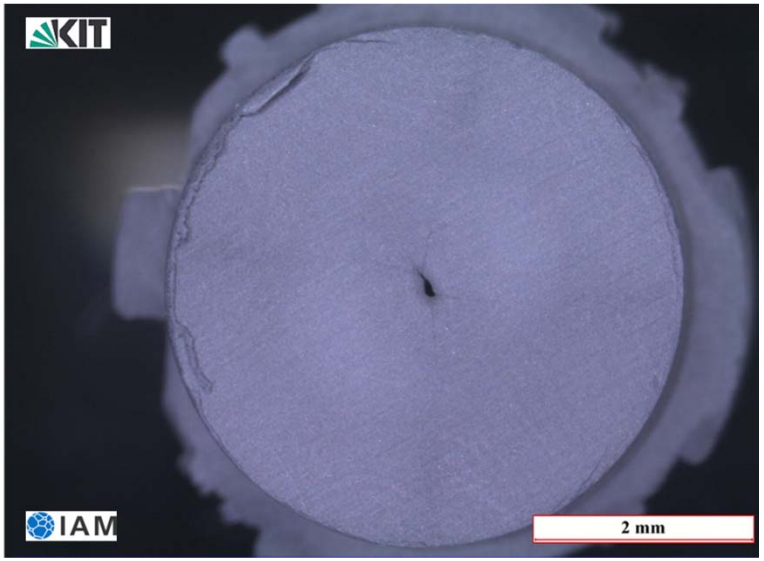
Reduction of membrane thickness due to PIM + embossing process

Variation of main parameters: embossing force, gap width,
and embossing delay time

Classification (from 1 to 5) of moulded membrane carriers



Class 1 sample: no visible failures



Class 5 sample: clearly visible voids

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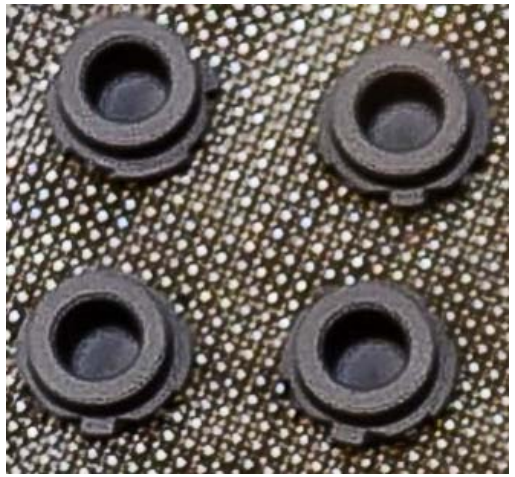
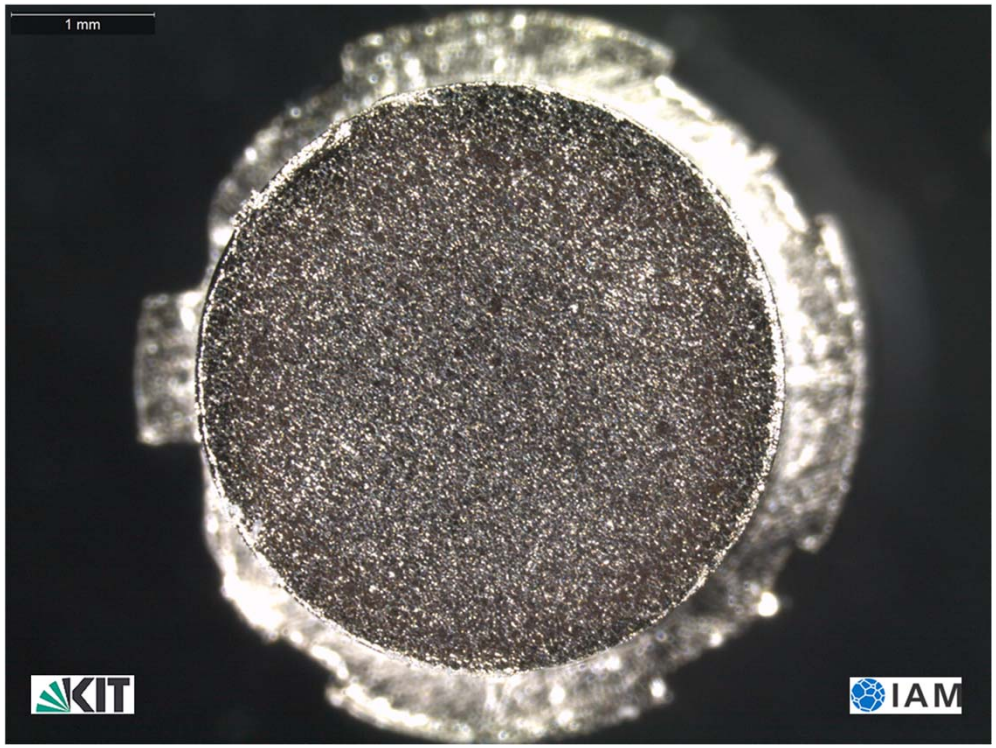
Thermal treatment

membrane carriers before debinding



class 1 sample after sintering



Porosity
1.6 – 2.1%

Pore sizes
1.7 – 2.1µm

Minimum membrane thickness
≤ 200µm

Constancy membrane thickness
± 0.4%

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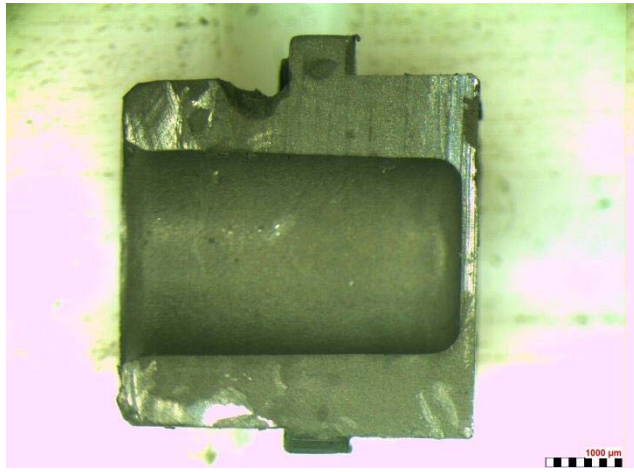
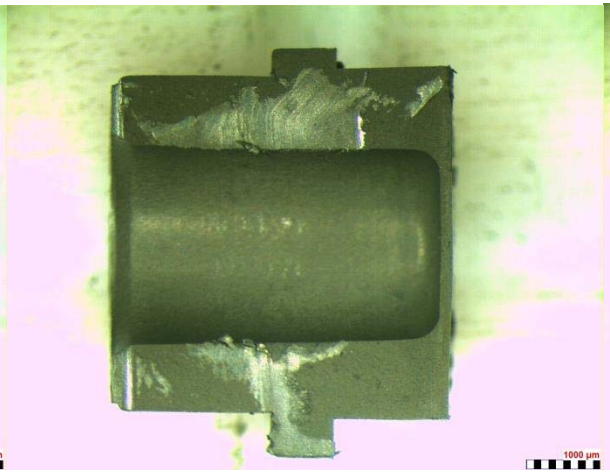
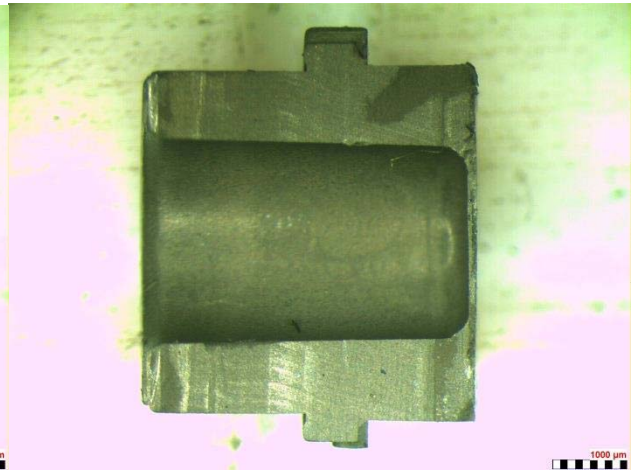
Further reduction of membrane thickness



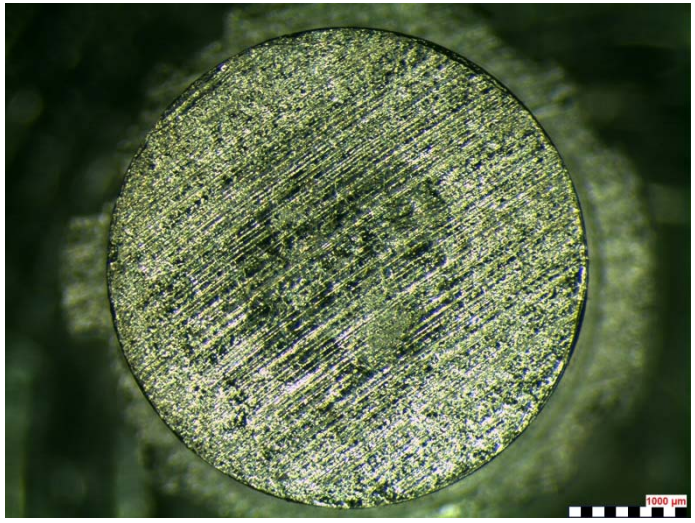
200µm



150µm



100µm



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

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Outlook

PIM + embossing process

- hardening tests
- microstructure investigation
- increase powder loading → 67Vol%
- improve powder composition (bi-modal)
- improve piston movement
- avoid feedstock-wall adhesion

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Thank you !