

Multi-Component Parts made by Micro Ceramic Injection Moulding

V. Piotter, E. Honza
T. Mueller, K. Plewa

Karlsruhe Institute of Technology (KIT)
Institute for Applied Materials (IAM-WPT)

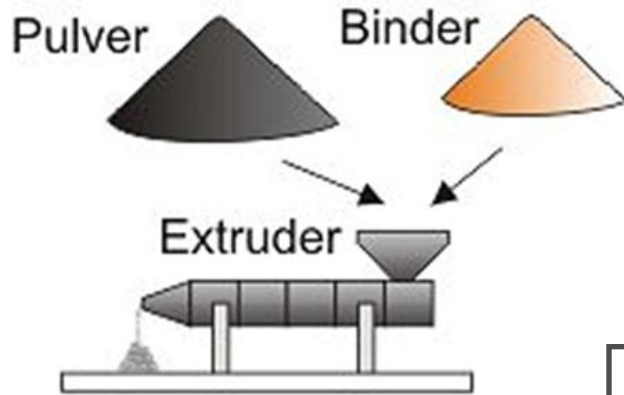
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- **2-Component Micro Powder Injection Molding (2C-MicroPIM)**
 - **fixed connections**
 - **movable connections**
- **Micro Inmould-labelling using PIM-Feedstocks**
- **Outlook**

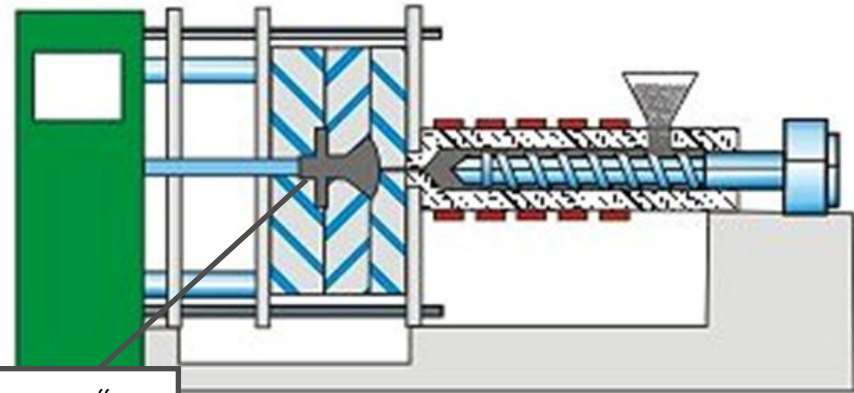
Micro Powder Injection Molding

© www.pulverspritzgiessen.de

Feedstock preparation



Injection molding



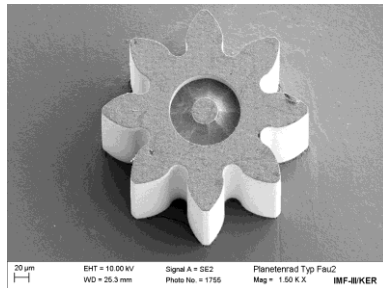
„green“
body

Debinding



Sintering





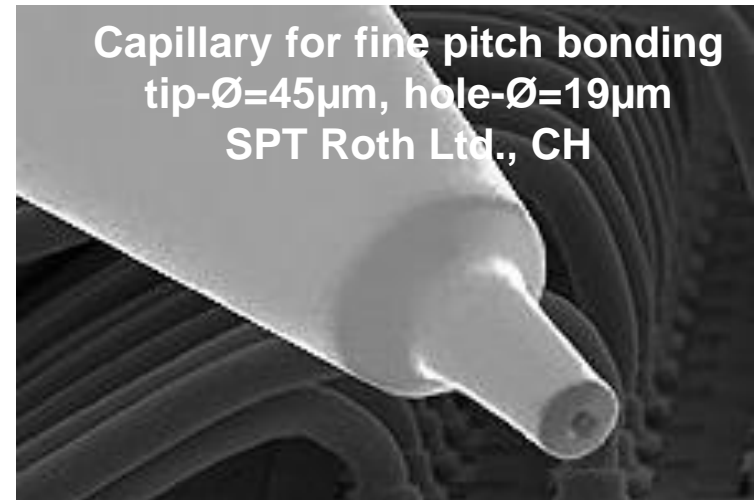
Ceramic gear wheel
outer- \varnothing approx. 275 μm



EPMA Award 2008 to
Parmaco MIM AG, CH



IT connector
ZrO₂
64 via-holes
octagon size 125 μm
Formatec Technical Ceramics bv, NL

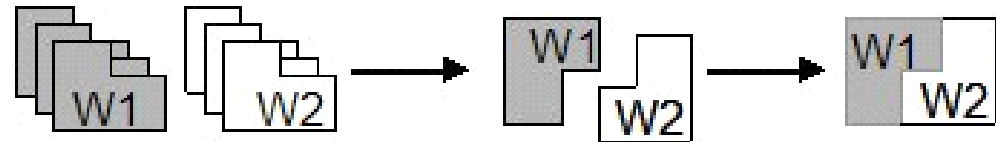


Multi-Component Micro Powder Injection Molding

Objectives

Reduction of **handling** and **assembly expenditure**

single-piece fabrication
+ assembly



2C-MicroPIM
– assembly



Multifunctional Products

with **complimentary** or **contradictionary** properties, e.g.

conductive

↔

insulating

hard

↔

tough

magnetic

↔

non-magnetic

bio-compatible

↔

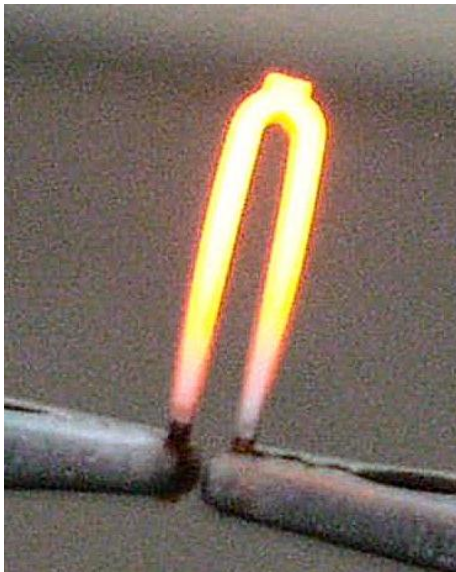
mechanically strong

tight

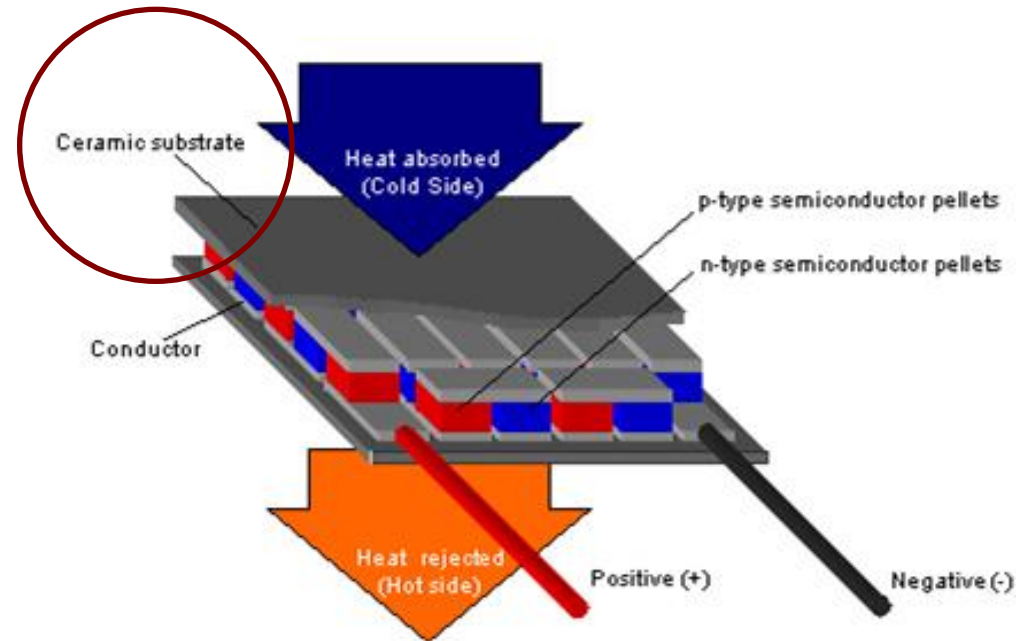
↔

porous

heating/cooling elements, electrical feedthroughs *SOFC components, TEG housings* and other possibilities

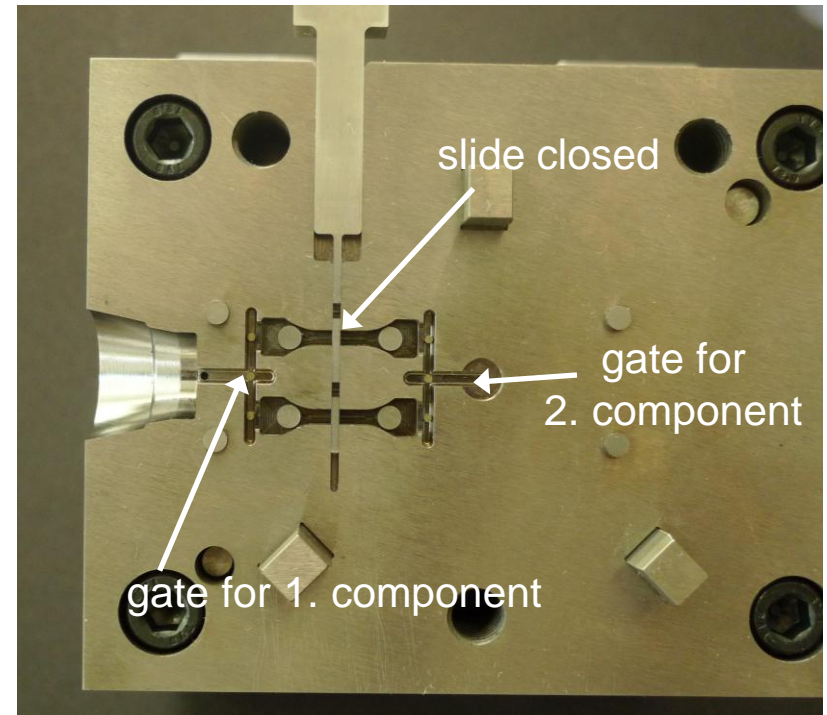
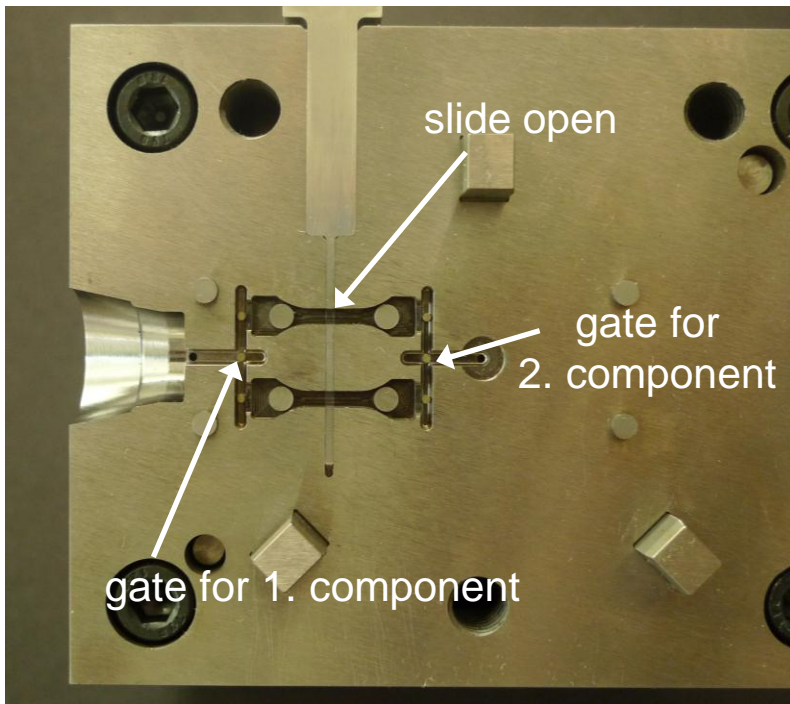
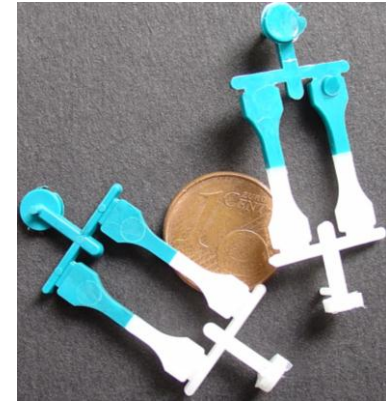
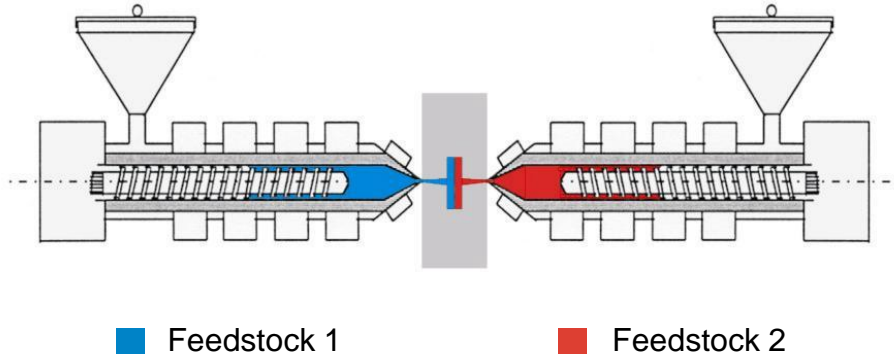


2-C ceramic heating element
 $\text{Al}_2\text{O}_3 + \text{Al}_2\text{O}_3/\text{TiN}$
square section $1 \times 1 \text{ mm}^2$
BMBF-Project „2K-PIM“



Source: <http://www.panco.de/thermoelektrik.php>

Multi-Component Micro Powder Injection Moulding



2C-MicroPIM – Mobile + Immobile Connections

Basic Rules

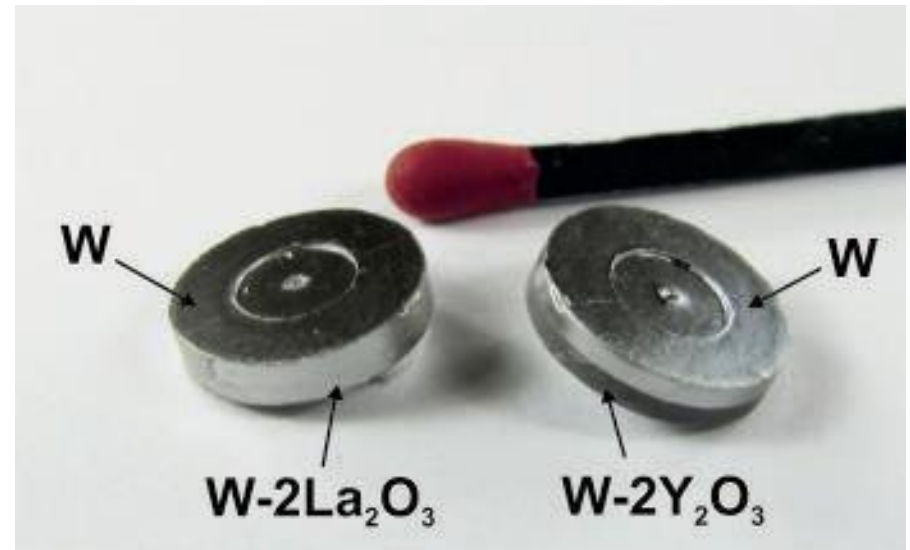
	Mobile	Immobile
Binder system	n. r.	compatible
Powder loading	inner section < outer section	nearly equal
Sintering temperature	inner section < outer section	nearly equal
Thermal expansion	nearly equal	nearly equal

2-Component PIM



Fraunhofer Institute, IFAM

Combination of a magnetic steel (17-4PH, 1.4542) with a non-magnetic steel (316L, 1.4404)

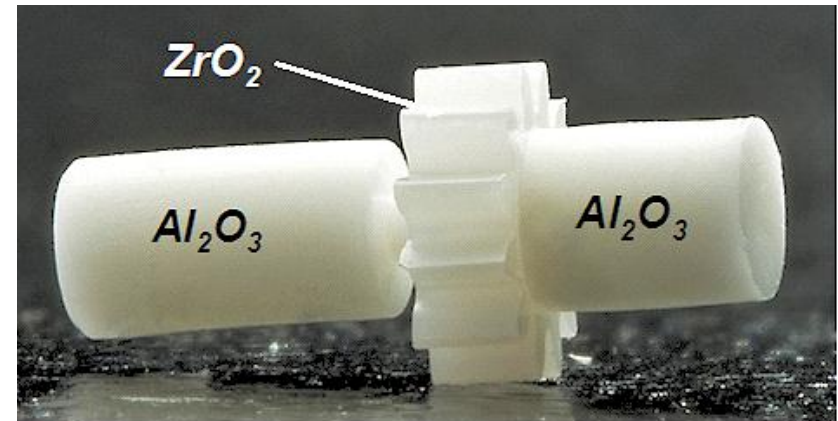
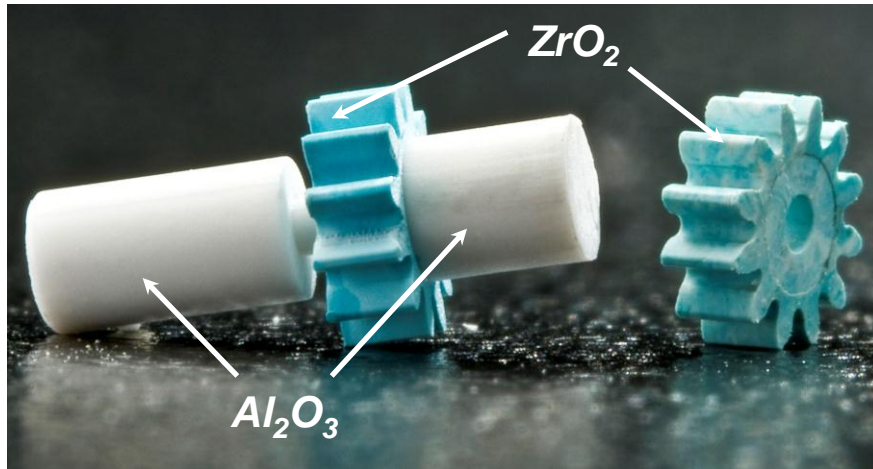


Combined high temperature-resistive tungsten and tungsten-alloys for power generation, e.g. Fusion reactors, KIT

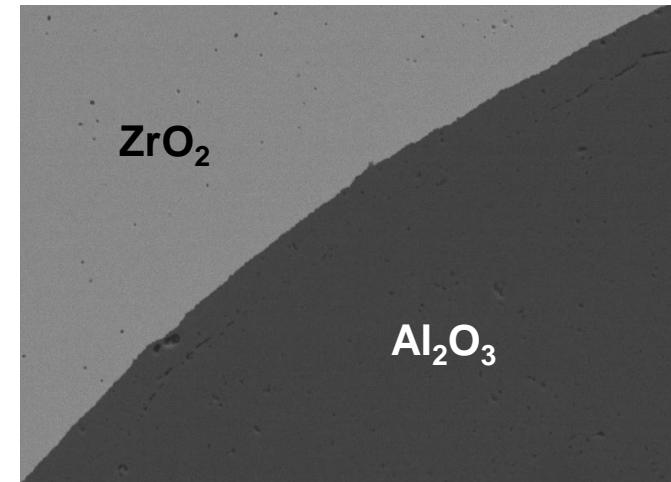


Hard metal WCxCo with different Co-contents (16% and 6%), ARBURG

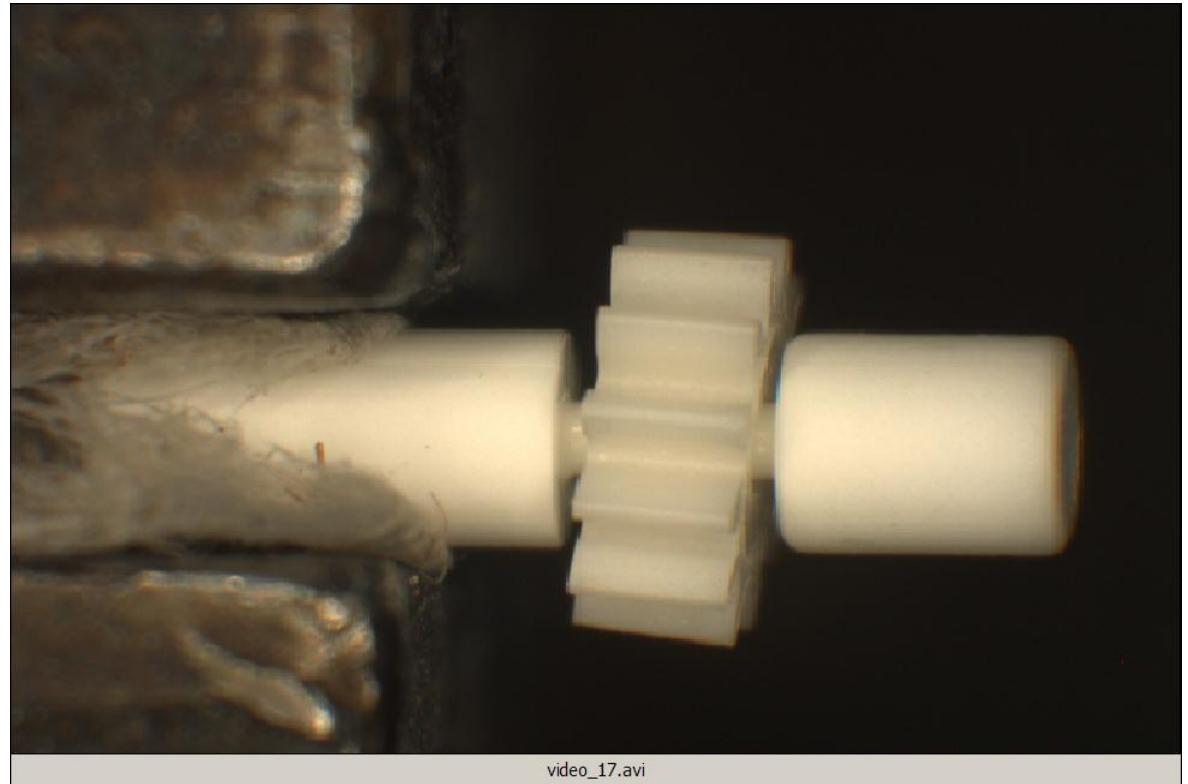
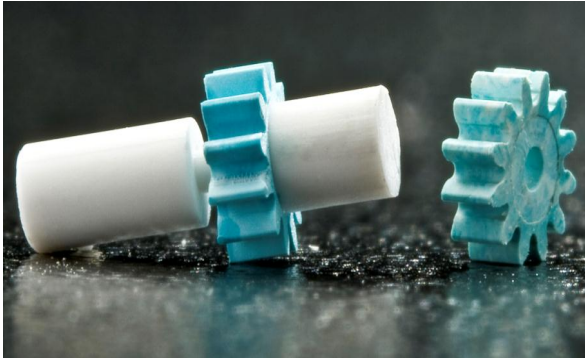
Multi-Component Parts Produced by MicroPIM

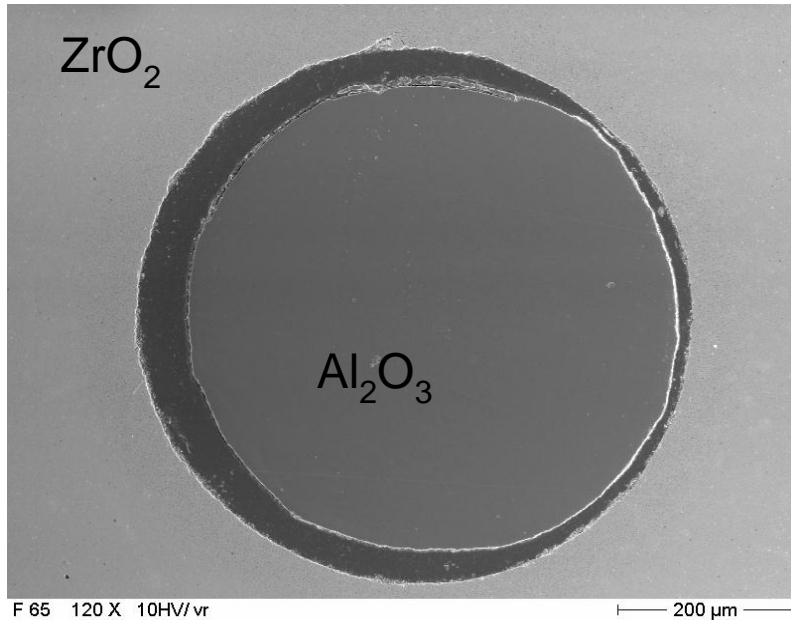


outer diameter (gear wheel):	2.932mm
height (gear wheel):	1mm
hub diameter:	0.65mm
slit tolerance:	0.1mm
shaft diameter:	1.65mm

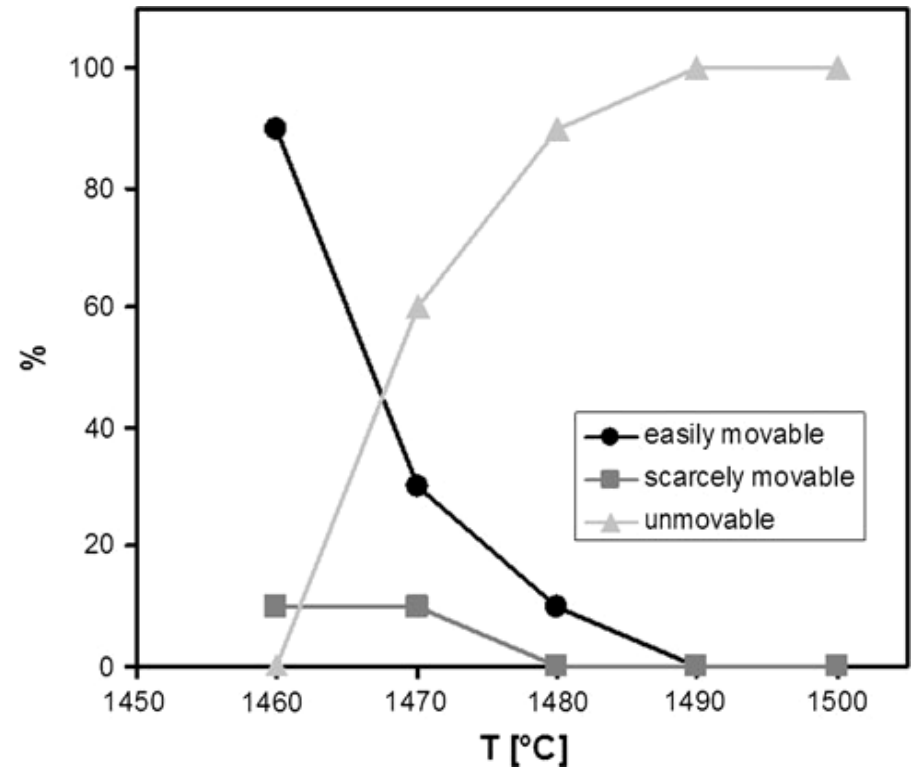


2C-MicroPIM – Mobile Connections





sintered at 1460°C

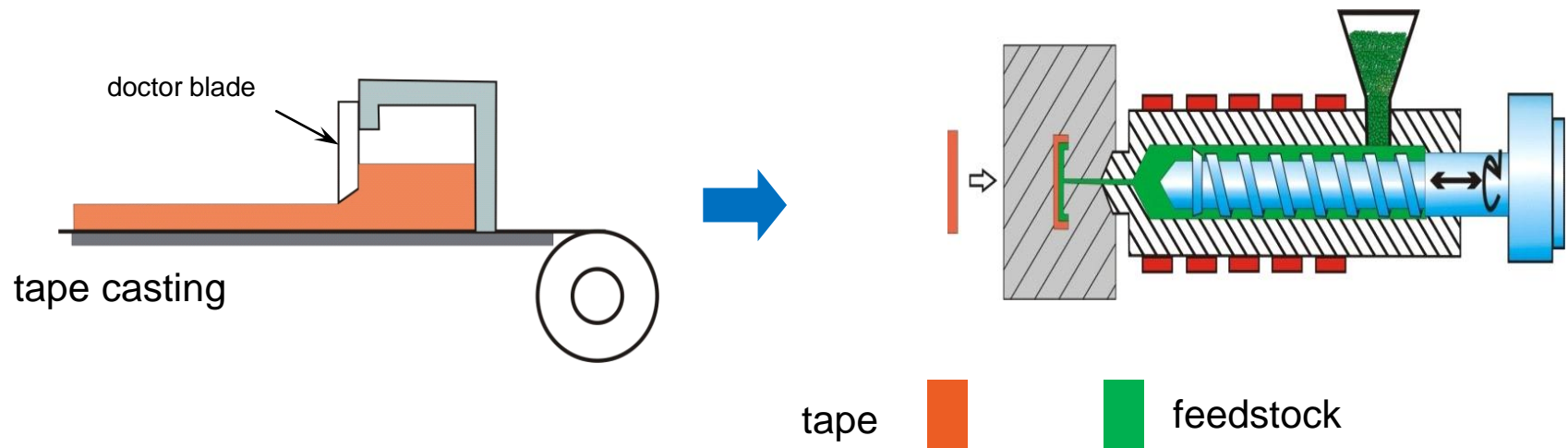


Sintering at low temperatures bears the risk of insufficient densities

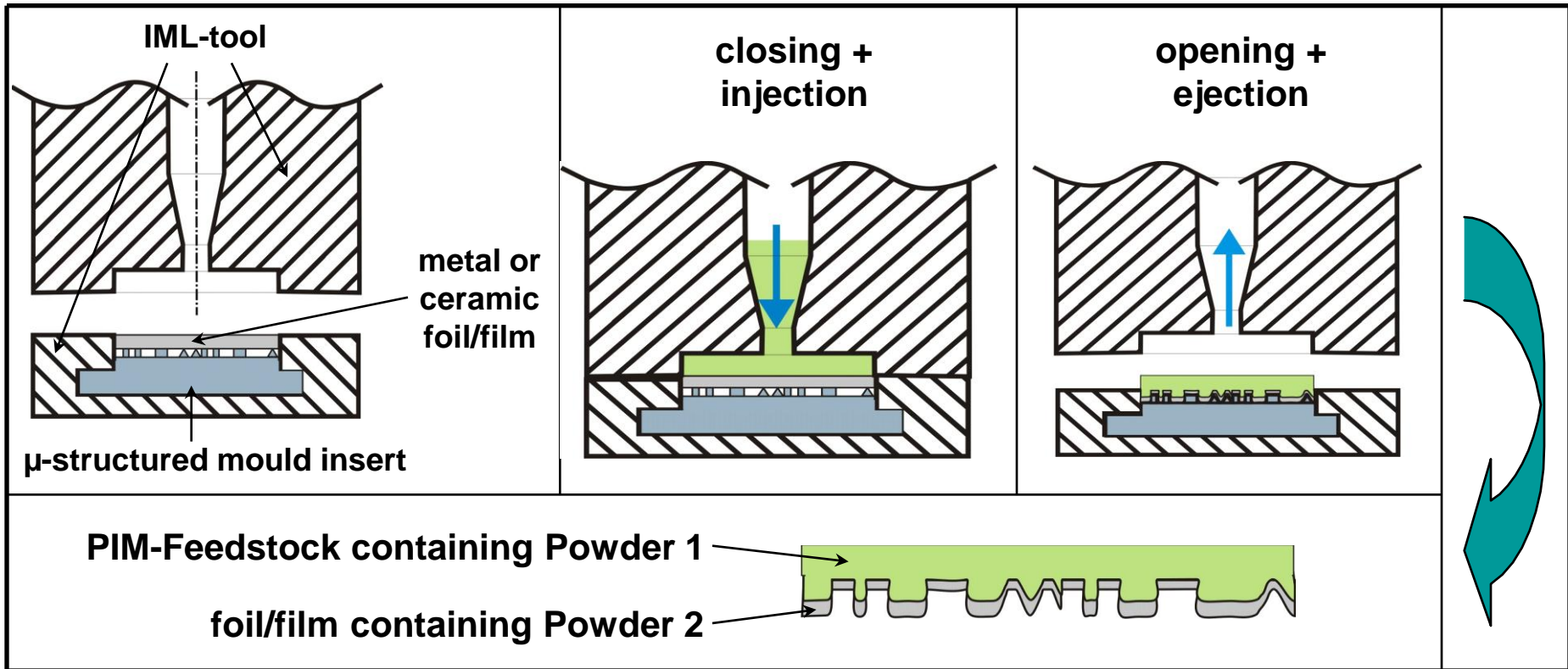
=> utilization of ultrafine powders

Micro Powder Inmould-labelling (IML-MicroPIM)

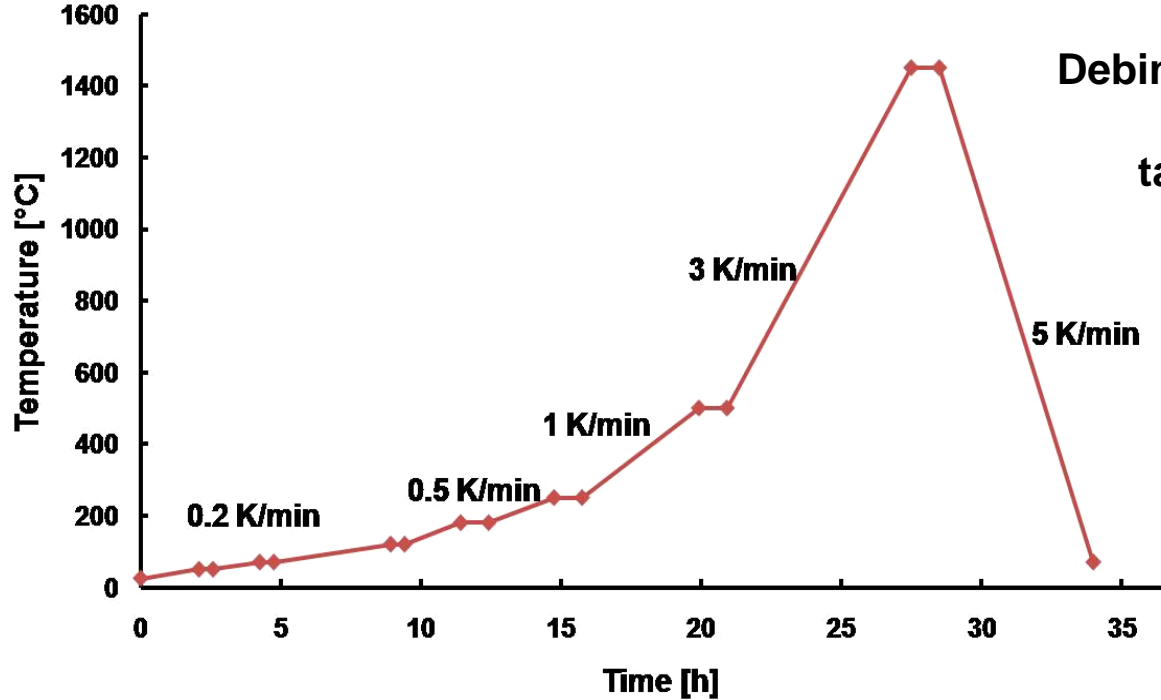
- combining the advantages of two shaping methods ...



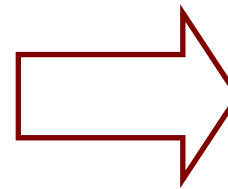
EU Project No. FP7-NMP4-2007-214122



Powder 2: functional or nano-particles applied on the structured surface
à **better accuracy, higher surface quality, functional properties etc.**

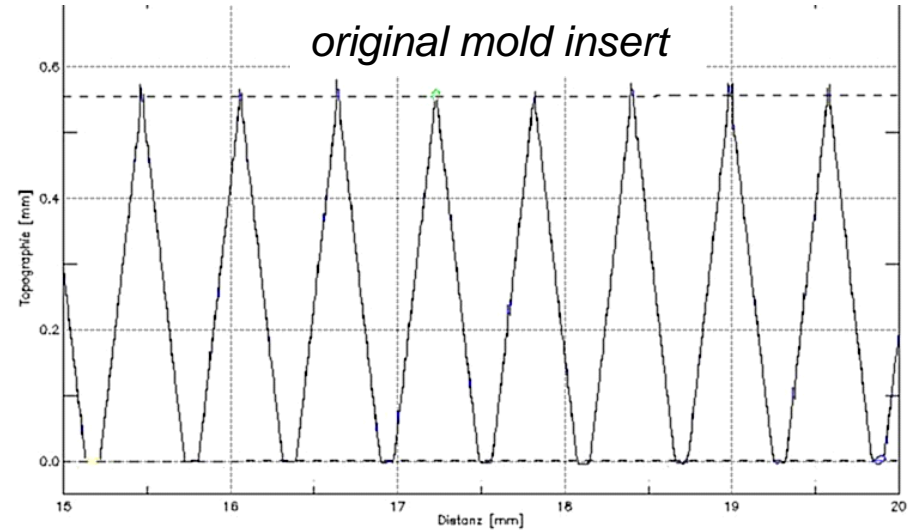
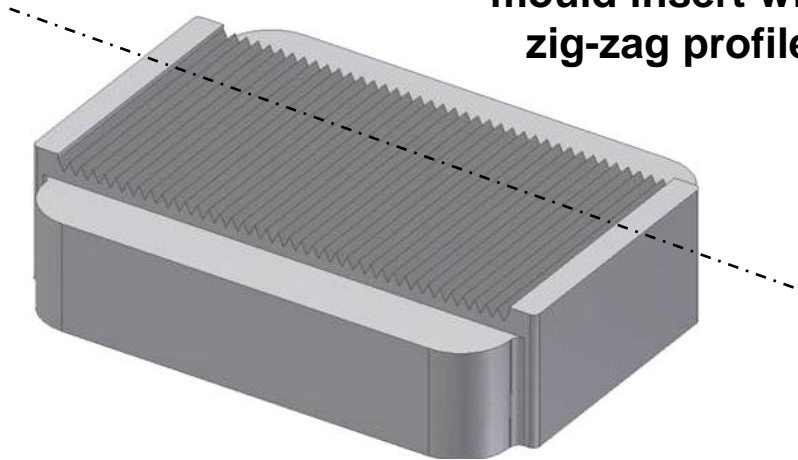


Debinding and Sintering procedure adjusted to both tape and feedstock powder

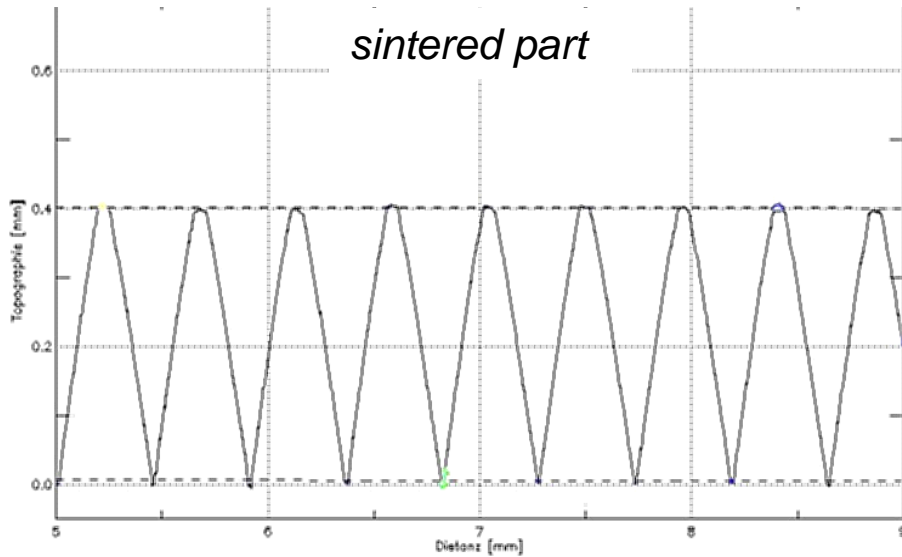


Accuracy tracking

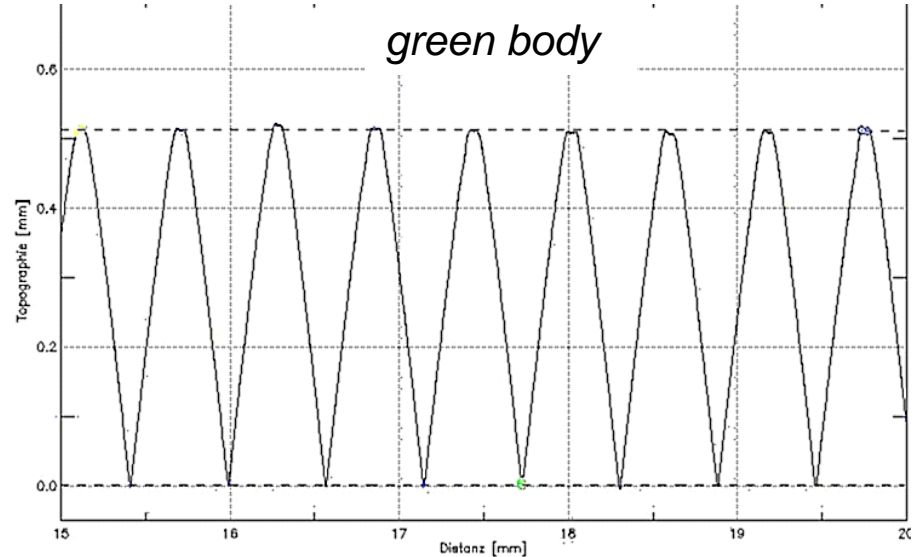
mould insert with
zig-zag profile



sintered part



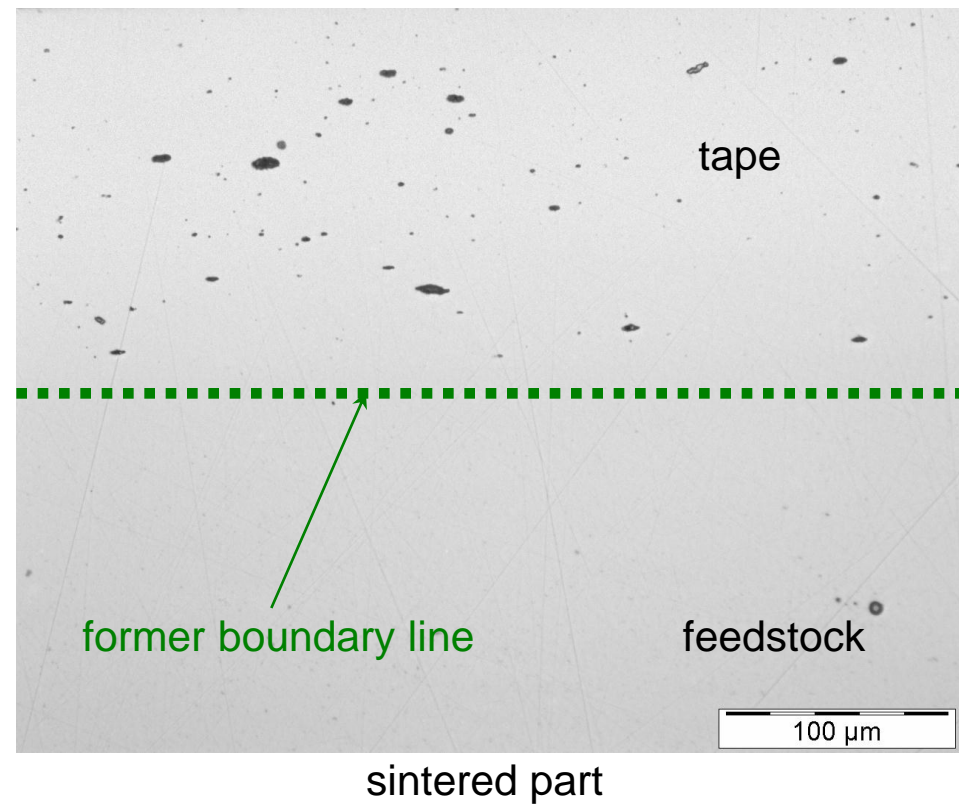
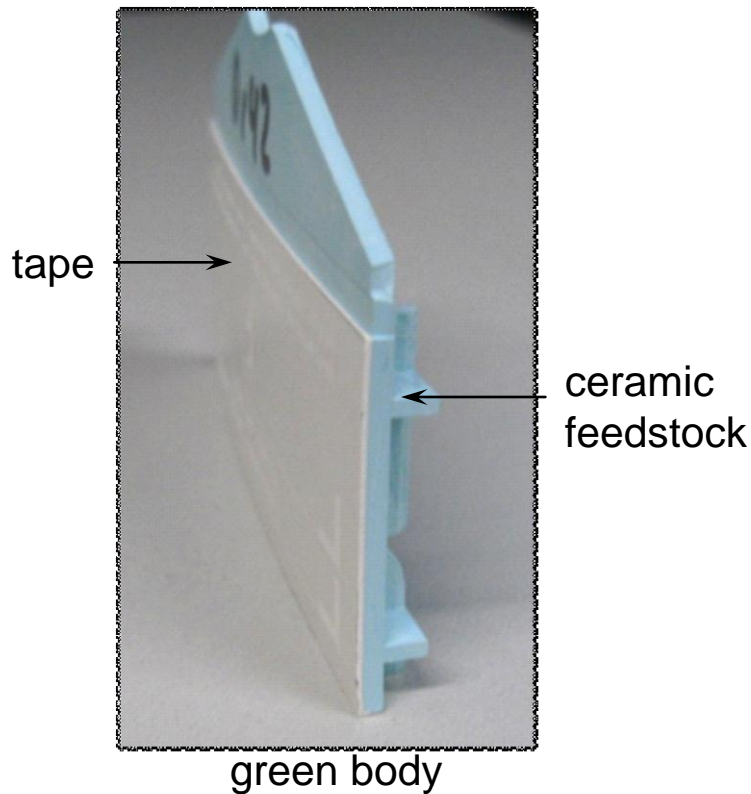
green body



Current Results (ZrO₂)

Present status:

- **tight** connection at the **interface**
- but deviations of the **entire** part



Outlook

- Expanding the range of **materials**
functional materials
fine and nano powders etc.
- Improvement of **dimensional accuracy** and **surface quality**
- Enhanced **multi-component** process variants
e.g. EU-Projects „Multilayer“ or „HITTEG“
- **Practical implementation**

Acknowledgment

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