Injection Moulding

Injection moulding allows the high economic mass fabrication of complex-shaped nano and micro components. These can be singular items or large bodies with nano- or microstructures on the surface, respectively. In both cases very high geometric accuracies and smallest tolerances can be achieved using e.g. LIGA-fabricated mould inserts. Besides the replication of polymers powder injection moulding (MicroPIM) allows for the micro fabrication of components made of a large variety of metals or ceramics. Having reached a reliable status, two-component injection moulding and inmould-labelling reveal strong advantages with respect to reduced mounting expenditures and the capability to produce multi-functional devices.

Contact

See KNMF website or contact the KNMF User Office.

Features

- Cycle times < 3 s – 6 min
- Largest replicated aspect ratio:
  17 for free standing structure
  (height: 2000 µm; width: 115 µm)
  25 for buried structure
  (height: 250 µm; width: 10 µm)
- Smallest replicated structural detail:
  < 100 nm for aspect ratio 1, in case of lower aspect ratio replication minima decrease correspondingly
- Special variants like compression injection moulding for enhanced accuracies
- Fabrication of metal and ceramic parts via powder injection moulding
- Multifunctional parts by two-component or inmould-labelling powder injection moulding
- Special equipment for designing / developing feedstock compositions
- Special equipment for thermal treatment available, e. g. hot isostatic pressing (HIP) applying temperature and pressure parameters on a worldwide unique high level

Limitations/constraints

- Relatively large efforts for tooling necessary
- Replication process very sensitive to mould insert's surface roughness
- Side wall draft angle or ejector slope is recommended for larger aspect ratios depending on the mould insert's roughness
- Limited undercuts
- No hollow parts in one step fabrication possible

Materials

- 1- and 2-component injection moulding with polymers, metals , and ceramics
- Polymers: nearly all thermoplastics and thermoplastic elastomers
- Functional polymer-based nanocomposites with improved optical, dielectric or conductive properties (e. g. PMMA/CNT, PC/Al_2O_3 a. o.)
- Feedstock development for customer-specific materials using e.g. nano-sized powders
- Metals: PM steels like 17-4PH and 316L, Cu, W and W-alloys, hard metals
- Ceramics: oxide ceramics like ZrO_2 and Al_2O_3, Si3N4, mixture ceramics like TiN-Al_2O_3
- with defined material properties, e.g. electrical conductivity
- Subsequent densification and reduction of porosity by HIP

Typical structures and designs

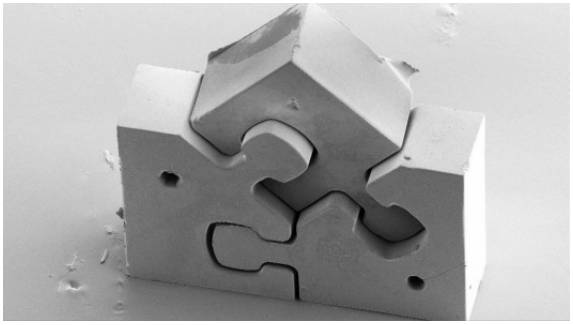

Fig. 1: Smallest puzzle of the world whose pieces have been made of PMMA using singular LIGA mould inserts.

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Injection Moulding

Typical structures and designs *(continued)*

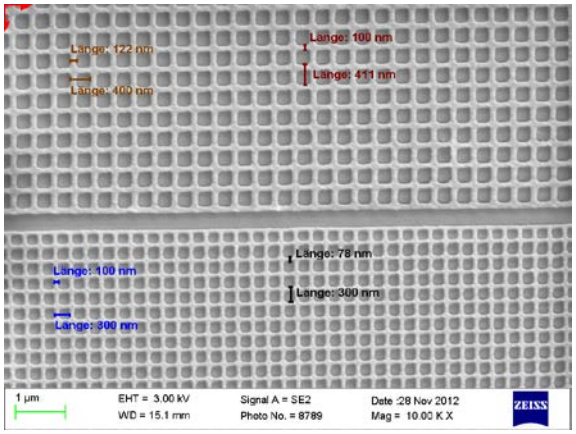

Fig. 2: SEM figure of polymer part (PMMA) with nano-sized structures made by injection moulding. (Länge ≙ length).

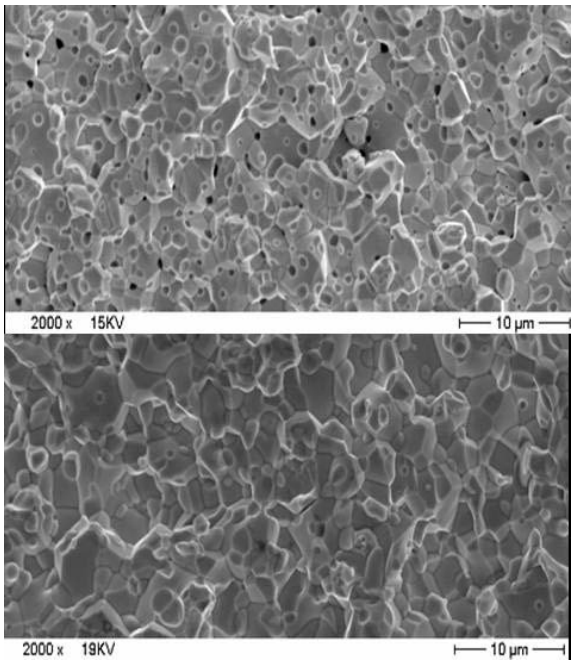

Fig. 3: SEM-picture of pure tungsten after sintering (above), the same material after additional HIP densification showing significantly reduced porosity (below).

Fig. 4: Gear wheel/shaft sample made by two-component injection moulding of alumina (shaft) and zirconia ceramic (gear wheel). Combined sintered part (left) and green body (right).

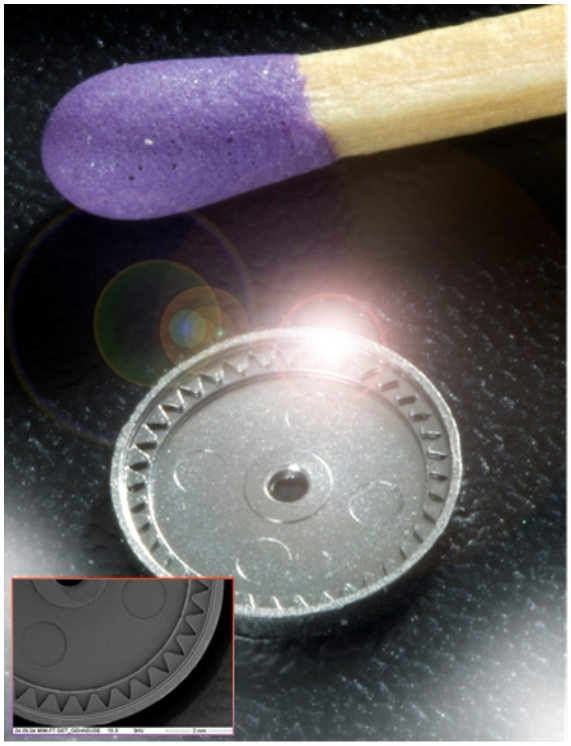

Fig. 5: Ring gear of planetary gear set, 1.4542.

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