Variation of the use of UV-LIGA Mold Inserts for the Fabrication of Single Polymeric- and Metallic- Microparts

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1 Introduction

The miniaturisation of technical parts is an important topic in industry. There was a continuous growth of the microsystems technology market in the last years. The economic growth until 2020 is predicted to 10% [1]. In this growing market the mass production of polymeric and metallic microparts with the corresponding replication and tool fabrication processes plays an increasingly important role. There are several established manufacturing technologies to fabricate mold inserts for micro injection molding like µ-EDM, µ-milling, laser sintering, laser ablation, silicon technologies etc. [2]. But the one process that has unique properties is the LIGA-process: in this process really smooth surface roughnesses (Ra < 30 nm) can be produced, whereas the technology gives nearly unlimited lateral design freedom and high aspect ratios with a high reproducibility [3].

Two variations for the use of UV-LIGA mold inserts are presented in this work: the fabrication of polymeric microparts by micro injection molding and the multi-component injection molding and electroplating (MSG) process to produce metallic microparts.

First the use of mold inserts fabricated by the UV-LIGA process [3] (manufactured by Mimotec SA) to produce single polymeric microparts in a novel way is presented (Figure 1). The new concept enables the production of high aspect ratio single polymeric microparts without using any ejector pins during the demolding process. Furthermore the microparts are separated from the sprue after injection molding.

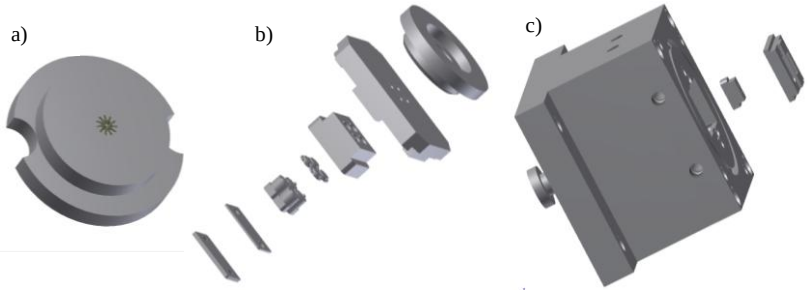

Figure 1: a) Design of the UV-LIGA mold insert; b) and c) Tooling concept for use in a Microsystem50 micro injection molding machine

Secondly a general new process is presented which is used to replicate LIGA structures by a combination of multi-component injection molding and electroforming (MSG Process; Figure 2) [4]. The process is based on the highly accurate reproduction of surface details through injection molding to build a microstructure into a two-component template and electro deposition of e.g. nickel, into this cavity. This electroplated micropart is the replication of the former structure.

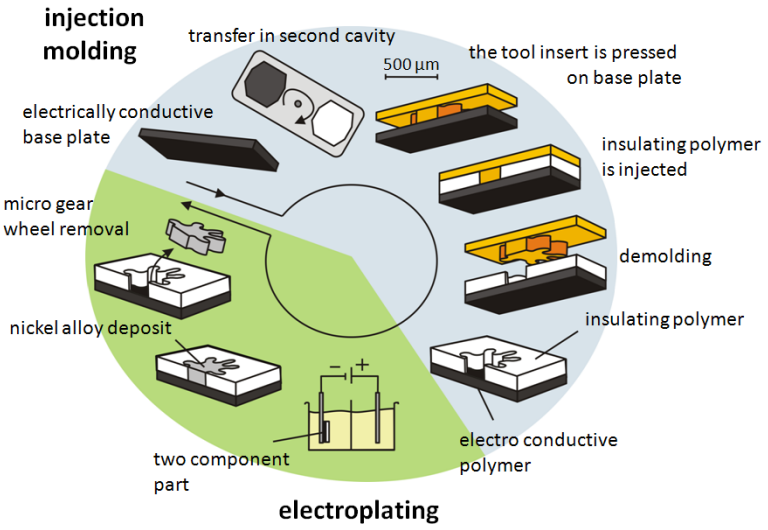

Figure 2: Process sequence of the MSG process [4]

2 The UV-LIGA mold insert

On the face of the UV-LIGA nickel plate (Figure 3a and 3b), which is used for the first tests of the new molding concept, 48 cavities and 3 reference structures are placed. Every cavity on the nickel plate can be used after a high speed cutting (HSC) milling process as a single mold insert (Figure 1a). For the precise layout of the single mold inserts three reference structures with 2 mm in diameter and 400 µm depth are fabricated by the LIGA process and thus gives the precise position of the cavities during milling. The cavities are microstructures with aspect ratios up to 10 and a depth of 400 µm. Examples for structures are numbers from 0-9, puzzle structures, rotor structures and pinion structures (Figure 3c).

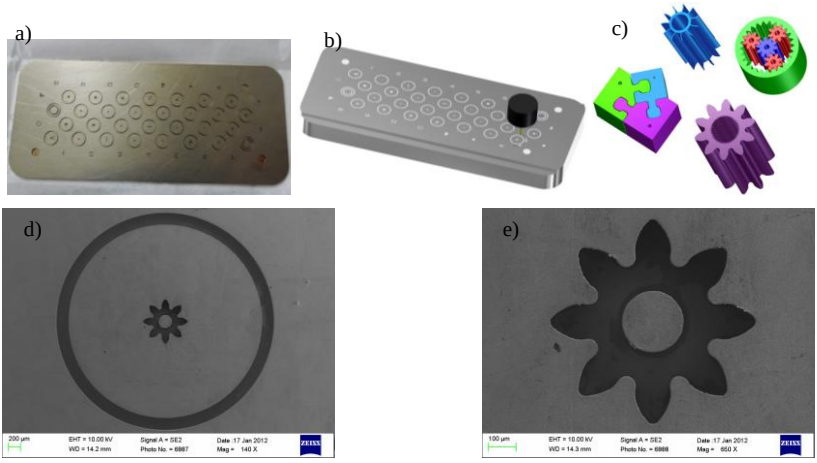

Figure 3: a) Nickel plate after the UV-LIGA process; b) Nickel plate (CAD-model) c) Examples of structures on the LIGA design; d) and e) SEM pictures of pinion structure on the LIGA nickel plate

3 Templates for the MSG process

To fabricate metallic microparts by the MSG process, two component polymer templates fabricated by multi injection molding are needed (Figure 4) [5]. The templates have a conductive base plate (carbon black-filled polyamide 12) which is produced in a first injection step. A homogeneous conductivity of this base plate is essential for the later electroforming step. Therefore optimised injection parameters in the injection molding process are necessary [4]. In a second injection step a non conductive polymer is used to produce an insulated negative form from the micro-

structures on the base plate [4]. The main challenge in the second injection step is to reach a fixed connection between the base plate and the insulating polymer [6].

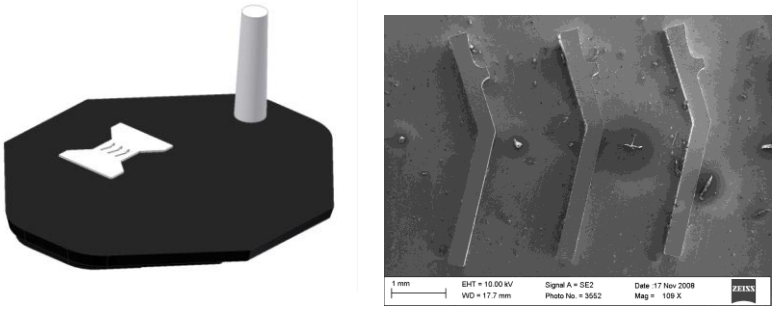

Figure 4: a) Two component template for the replication of coil cores, b) SEM figure of the coil cores used for a micro gripper [7]

4 Conclusion

A novel concept to produce single polymeric micro parts with LIGA mold inserts was demonstrated. Furthermore the MSG process can be used to fabricate metallic microparts using LIGA mold inserts.

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