Two process chains for creating functional surfaces on mold for 3D geometry

Zhang, Yang; Hansen, Hans Nørgaard; Pedersen, David Bue; Tosello, Guido

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Yang Zhang, Hans Nørgård Hansen, David Bue Pedersen, Guido Tosello

Technical University of Denmark, Department of Mechanical Engineering

Polymer products with functional surfaces are applied in many fields such as medical and bio technology [1][2]. It is believed that certain types of micro- or nano- structured surfaces can enhance tissue anchoring [3]. However, most technologies for the fabrication of micro-structured functional surfaces are still limited to flat geometries or geometries with constant curvature [4] . Typically products that need micro structuring on the surface have a three dimensional and complex geometry. There are huge demand for investigation in establishing the micro structures on the surface of a 3D mold. This paper describes and compares 2 approaches for fabricating micro- structured surfaces suitable for patterning of 3D shape cavity for injection moulding. The application investigated for the research is a part of a fixture for electrodes to be implanted inside human body. It is a ring with four wings as illustrated by Figure 1.

Figure 1 The ring with 4 wings. The overall dimension is approximately 7mm. It is a fixture for electrode implanted inside human body. the application will require micro features to be applied on all over the surface which is exposed to cells, i.e. the surface of the wings, and the external surface of the ring.

The first approach is to use pre-fabricated plate with micro-structured surface as an inserts inside the cavity. Then the nickel plate was machined into pieces with a taperzoidal cross section and embedded into the cavity as inserts, as illustrated by Figure 2.

The second approach is to use a soft tooling process, where the inserts were produced by additive manufacturing process. Free-form micro-structuring can be realized in this process. Figure 4 shows the image of insert and polyethylene replica produced by injection moulding.

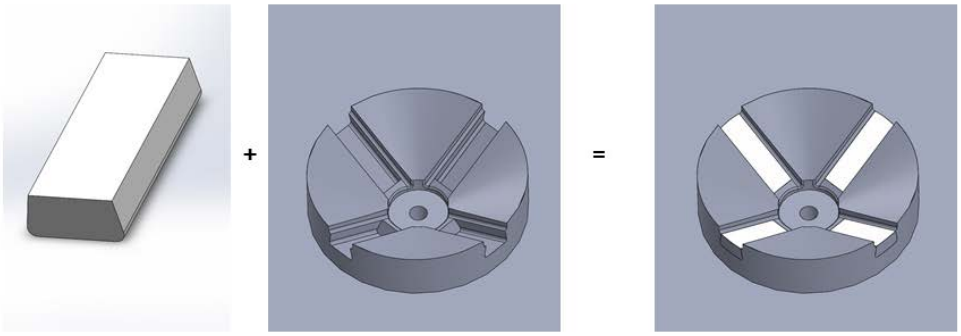
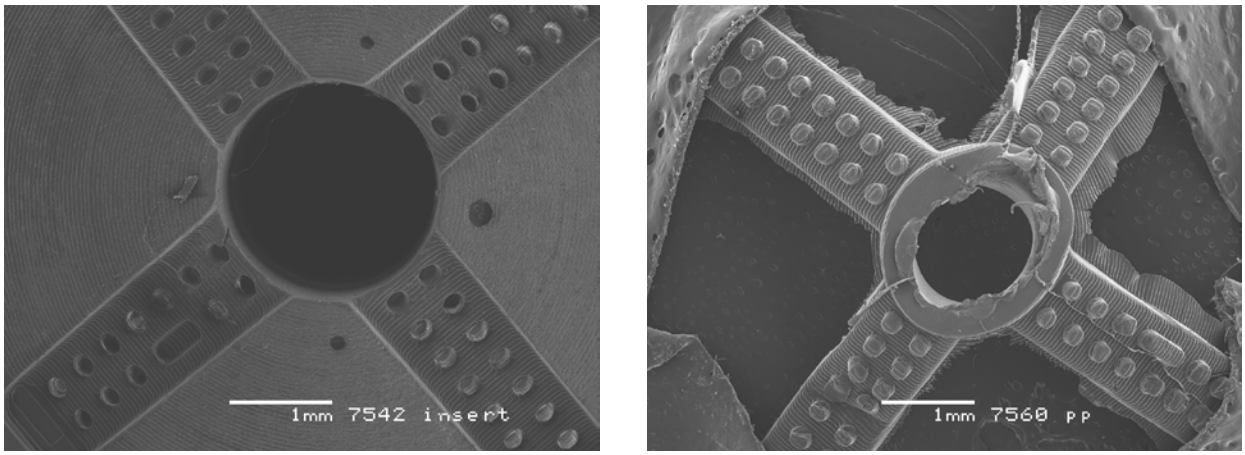


Figure 2 3 Inserts made from prefabricated Ni disk is assembled with mould cavity. From left to right: the Ni piece with micro structure on the surface, cavity for the injection side and the assemply. The bright color shows the micro-structured side.



(a) (b)

Figure 4 (a) The insert produced by additive manufacturing (b) is the polymer parts produced by injeciton moulding using the AMed inserts.

[1]. Doan N, Qiang L, Li Z, et al. Low-Cost Photolithographic Fabrication of Nanowires and Microfilters for Advanced Bioassay Devices. *Sensors*. 2015;15(3):6091-6104. doi:10.3390/s150306091.

[2]. Lucchetta G. Effect of injection molded micro-structured polystyrene surfaces on proliferation of MC3T3-E1 cells. *Express Polym Lett*. 2015;9(4):354-361. doi:10.3144/expresspolymlett.2015.33.

[3]. Wilkinson CD., Riehle M, Wood M, Gallagher J, Curtis a. S. The use of materials patterned on a nano- and micro-metric scale in cellular engineering. *Mater Sci Eng C*. 2002;19(1-2):263-269. doi:10.1016/S0928-4931(01)00396-4.

[4]. Hansen HN, Hocken RJ, Tosello G. Replication of micro and nano surface geometries. CIRP Ann - Manuf Technol. 2011;60(2):695-714. doi:10.1016/j.cirp.2011.05.008.