Injection Molded Microfluidic Devices

Dispensing Systems for Life Sciences

Liquid handling becomes more and more important in different areas of modern technology. In particular medical technologies, chemical analysis technologies in pharmacy, biochemistry and chemistry have a great demand for miniaturized liquid handling systems with high functionality. Together with the HSG-IMIT in Villingen-Schwenningen and the IMTEK in Freiburg, HSG-IMAT has developed different microfluidic elements, manufactured by micro injection molding.

In microfluidics for life sciences, the handling of liquids in the range of 0,1 nl up to 100 nl is requested, since the reagent liquids can be very expensive or only available in small amounts. So far those dispensing elements are often produced using costly glass or silicon technologies. The elements are usually disposables, because cleaning is mostly impossible or at least cost intensive. Fabricating disposable microfluidic dispensing elements from cost effective thermoplastics by injection molding could be a solution for these requirements.
Fig. 1 shows a injection molded microfluidic dispenser array developed within the scope of an AiF project. The device consists of 24 dispensing elements. Basic element of the dispensing principle is a microfluidic dosage-chip with reservoirs, 100 µm wide and 80 µm deep channels and nozzles with a diameter of 100 µm, as shown in Fig. 2. The molding cavity made of steel, was produced at HSG-IMAT by high-speed micro milling. The challenge in producing the cavity, were the 24 tapered core pins with a diameter of 100 µm at the nozzle orifice. With this mold we manufactured microfluidic dispenser arrays made of cyclic olefin copolymer (COC) by injection molding on a conventional Arburg molding machine. The nozzle diameters of the molded parts showed fabrication tolerances of less than 10 µm. Fig. 3 shows a SEM-micrograph of the cross section of a nozzle. The dispensing performance of the pneumatic actuated devices was characterized by gravimetric measurements. A mean dosage volume of all nozzles was measured to be 50 nl with a reproducibility better than 3,5%.
In Fig. 4, a totally different dispensing element is shown. The microfluidic dispensing head for liquids from 10 nl to 100 nl, was also developed within the scope of an AiF project. Basic element of the microfluidic dispensing head is a high-flexible and high-strength polymer microtube. Using insert molding, the microtube is connected to the thermoplastic adapter. A piezo stack actuator drives the polymer microtube. The fast displacement of the piezo stack actuator results in a jet ejection of fluid. So there is a contact free delivery of fluid and no contamination of the actuator with media. The simple geometry and the easy packaging by clamping are the main advantages of the microfluidic dispensing head.

Characteristics

- Microfluidic dispensing units made in thermoplastic by injection molding
- Cost effective for large amounts
- Disposable elements
- Sufficient reproducibility
- Cavity made by high speed micro milling

Applications

- Life science applications in
  - Medicine
  - Biochemistry
  - Pharmacy
  - Chemistry
- Dosage of glue in micro assembly technologies
- Dosage of varnish and paints

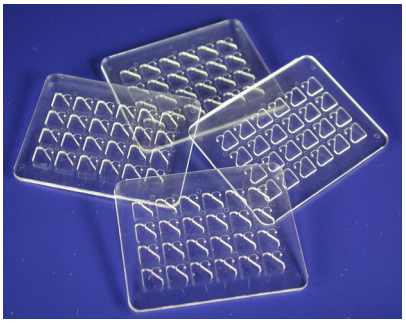

Fig. 1: Injection molded microfluidic dispenser array

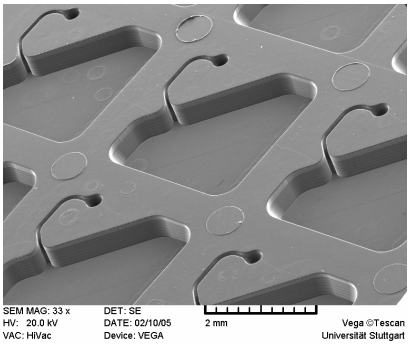

Fig. 2: SEM-micrograph of reservoirs, channels and nozzles

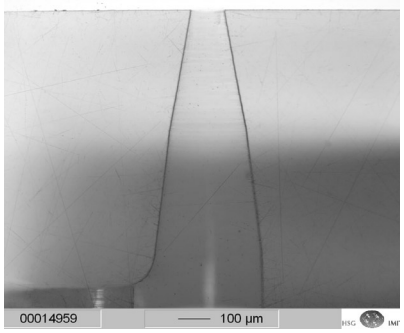

Fig. 3: SEM-micrograph of the cross section of a nozzle

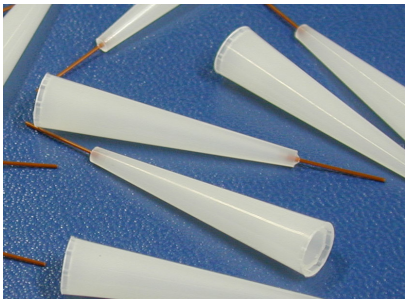

Fig. 4: Microfluidic dispensing head

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