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Disposable Polymeric Micro-Cantilever Arrays for Biomedical Applications

P. Urwyler[1 3], O. Haefeli[2], H. Schift[1], J. Gobrecht[1 2], and B. Müller[3]

[1]*Paul Scherrer Institute, Villigen, Switzerland.* [2]*University of Applied Sciences Northwestern Switzerland, Windisch, Switzerland.* [3]*Biomaterials Science Center, University of Basel, Switzerland.*

INTRODUCTION: Micro-fabricated cantilevers, similar to those used in scanning probe microscopes, have become increasingly popular as transducers in chemical and biological sensors. In the field of biomedicine, silicon-based micro-cantilevers are applied but they are often too expensive for single usage. Polymer materials offer tailored physical and chemical properties including biocompatibility that can be combined with low-cost mass production. We have established the injection molding technique to fabricate different polymer cantilever arrays with dimensions in the micrometer range to be functionalized and calibrated for applications in biomedicine.

METHODS: The development and fabrication of disposable polymeric micro-cantilever arrays, as shown in Fig. 1, is based on thermal injection molding. The injection molding, well established on the millimeter scale and above, is adapted to the micrometer scale. The mold is rapidly heated so that the melt isothermally fills the cavity. Such a processing allows working within the standard injection molding cycle timeframe. The isothermal process facilitates the complete filling of high-aspect-ratio micro-cavities with a variety of polymer materials.

RESULTS: Micro-cantilever arrays (see Fig. 1) made of cyclic olefin copolymers (COC), polyoxy-methylen copolymers (POM-C), polypropylene (PP), and polyvinylidenfluorid (PVDF) were successfully injection molded. High performance polymers such as polyetheretherketone (PEEK) are conceivable, but have special processing conditions like elevated temperature requirements.

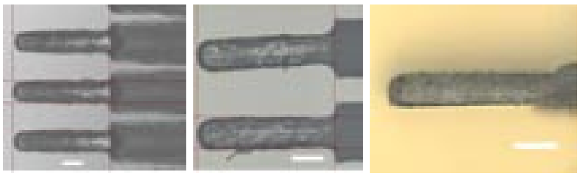

Fig. 1: Injection molded 100 µm-wide COC (left), POM (center) and PP (right) cantilevers. Scale bars 100 µm

The micro-cantilevers were flat enough to be characterized directly using the atomic force microscope (AFM). The resonance frequencies of selected cantilevers are summarized in Table 1. The heat tests, performed using the Cantisens® Research platform (see Fig. 2), shows the proper behavior of the cantilevers.

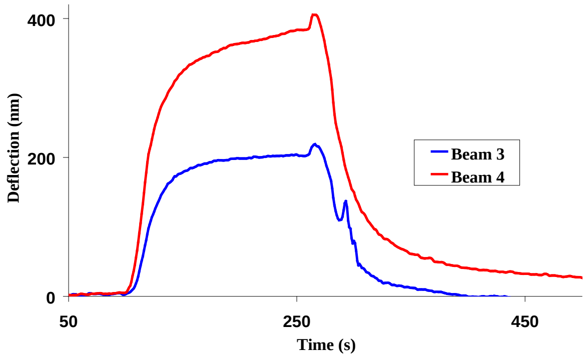

Fig. 2: Heat test from 22 to 32 °C with injection-molded PVDF cantilevers. (Beam 3 – deflection 200 nm, beam 4 – deflection 375 nm).

Table 1: Micro-cantilever resonance frequencies

Material Beam No	Theoretical	Experimental (AFM)
PVDF 1	43 kHz	79.27 kHz
PVDF 2		79.00 kHz
PVDF 3		79.05 kHz
PP 1	53 kHz	78.7 kHz
PP 2		78.9 kHz
PP 3		78.6 kHz

CONCLUSIONS & OUTLOOK: This work presents injection molding of polymeric micro-cantilevers with an aspect ratio as large as 10. The heat tests and the preliminary biochemical thiol-tests suggest that cantilevers are mechanically compliant for usage in biochemistry and biomedicine. The cantilever array sensors will support the selection of advanced surface-modified substrates and medical implant surfaces. Here, we foresee the measurement of contractile cell forces as described earlier.[1]

REFERENCES: [1] J. Köser, J. Gobrecht, U. Pieles, B. Müller (2008) *Eur. Cells Mater* **16**:38.

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