European Cells and Materials Vol. 20. Suppl. 3, 2010 (page 261) ISSN 1473-2262

Polymeric Micro-Cantilever Arrays for Sensing

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INTRODUCTION: In the field of biomedicine, silicon-based micro-cantilevers are applied, but are often too expensive for single use. Polymer materials offer tailored physical and chemical properties, including biocompatibility. 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 is based on standard thermal injection molding using precisely machined, laser ablated metal molds. The injection molding well established on the millimeter scale and above, is adapted to the molds with extended micro cavities.

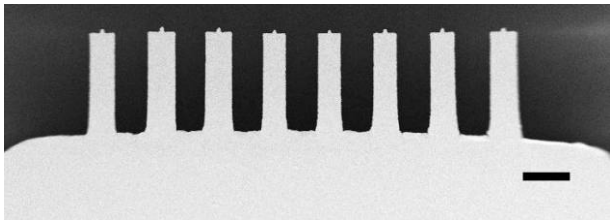

Fig. 1: SEM micrograph of injection molded PP micro-cantilever array. Scale bar 200 µm.

Table 1. Micro-cantilever resonance frequencies. Calculated 30µm – 58.6 kHz, 40µm – 78.2 kHz.

Beam No	Measured (kHz) 30 µm thick		Measured (kHz) 40 µm thick	
	Air	Water	Air	Water
PVDF 1	79.42	41.12	79.99	61.15
PVDF 2	54.7	41.12	77.58	61.16
PVDF 3	59.86	41.12	79.99	61.12
PVDF 5	61.99	41.12	80.86	61.37
PVDF 6	47.04	41.12	74.91	61.16
PVDF 7	68.93	41.20	70.69	61.43
PVDF 8	76.5	41.12	77.61	61.47

RESULTS: Micro-cantilever arrays (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 require special processing conditions. The micro-cantilevers were characterized using the Cantisens® Research system. The resonance frequencies of the selected polymeric cantilevers in both air and water are summarized in Table 1. The bimetallic effect was demonstrated both in air (Fig. 2) and water with the heat tests. Deflections in the range of 10 nm – 15 nm have been detected in the thiol binding tests. The successful heat and thiol tests imply that the micro-cantilevers are mechanically compliant for use in biochemistry and biomedicine.

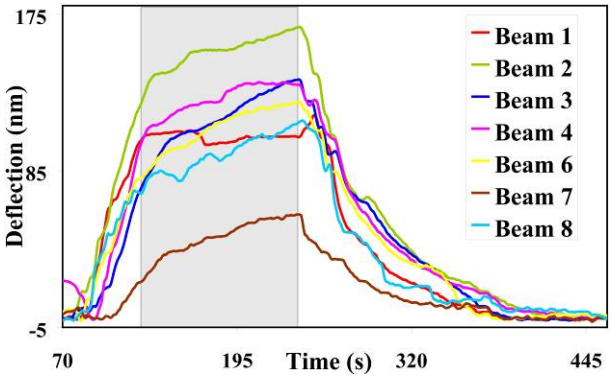

Fig. 2: Heat test (25°C to 35 °C) with 30 µm IM PVDF cantilevers in air. (Grey area- 35°C).

DISCUSSION & CONCLUSIONS: The resonance frequencies of the polymeric micro-cantilevers are better suited for gas sensing. The polymeric cantilevers can be functionalized to mimic implant surfaces and biocompatible substrates. The measurement of contractile cell forces as described earlier, [1] can also be applied to the functionalized polymeric cantilevers. Thus, the disposable cantilever array sensors will support the selection of advanced surface-modified substrates and medical implant surfaces.

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

ACKNOWLEDGEMENTS: Funding by the Swiss Nanoscience Institute is greatly acknowledged. We thank the members from the LMN-PSI, INKA, FHNW (IKT, IPPE), EMPA (K. Jefimovs), BMC, Concentris GmbH, KATZ for their technical assistance.