

Disposable Polymeric Micro-cantilever Arrays for Biomedical Applications

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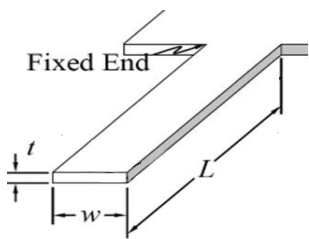
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Introduction

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

Cantilever Fabrication

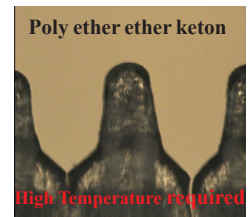
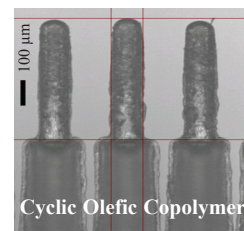
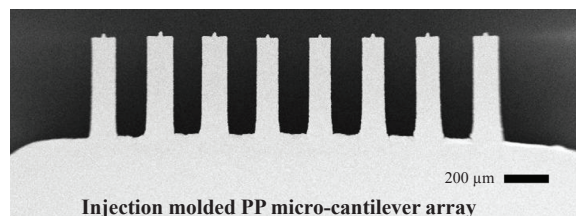
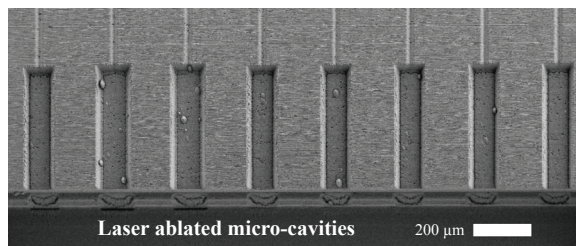


$$L = 500 \mu\text{m}$$

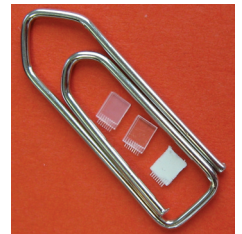
$$w = 100 \mu\text{m}$$

$$t = 20 - 50 \mu\text{m}$$

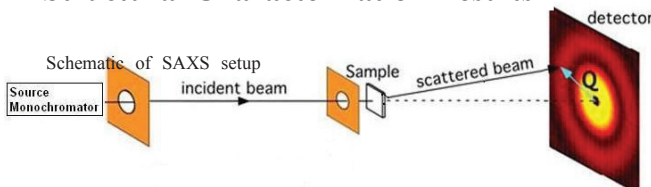
$$\text{Spring constant: } k = \frac{Ewt^3}{4L^3}$$



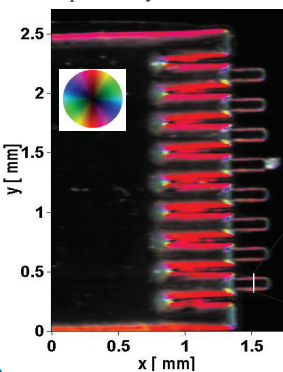
- Injection molding (IM)
- Mass fabrication
- Fine grain size steel molds
- **Precise micro machining**
- **High aspect ratio**



Structural Characterization Results

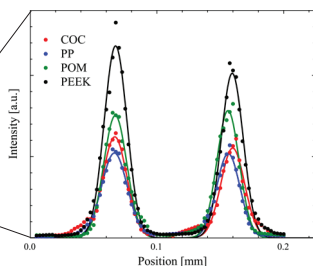


Orientation map of cantilevers in the periodicity 418-286 nm

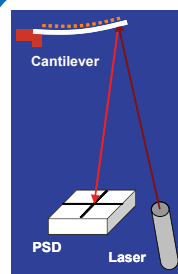


Small angle X-ray scattering reveals

- Long-range order orientation
- Orientational anisotropy
- Prominent rim (~9 μm) region



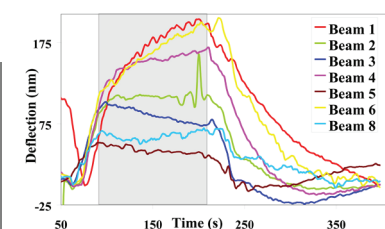
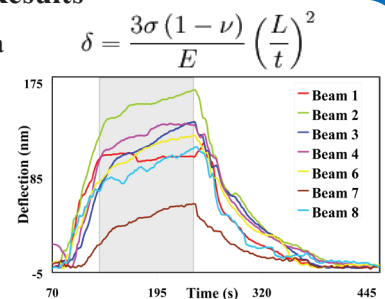
Characterization Results



- Stoney formula
- Nm deflection
- Sensitivity nN

Micro-cantilever resonance frequencies
30 μm – 58.6 kHz, 40 μm – 78.2 kHz

Beam No	30 μm thick		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



Heat test (25°C to 35°C) on PVDF micro-cantilevers in air (top) and water (below). Grey area shows temperature at 35°C

Conclusion / Outlook

- Cyclic Olefin Copolymer (COC), Polyoxymethylen Copolymer (POM-C), Polyvinylidenefluoride (PVDF) and Polypropylene(PP) micro-cantilever arrays successfully injection molded.
- Heat and thiol tests on injection molded cantilevers- mechanically compliant for sensing.
- Structural characterization reveals orientational anisotropy, long-range orientation of nanostructures.
- Resonance frequency measurements in liquid and air - suitable for gas and liquid sensing
- A sensor for investigating the effects of surface modified substrates and implant surfaces.

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