

# Variotherm Injection Moulded Micro-Cantilever Arrays for Sensing

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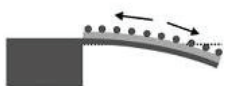
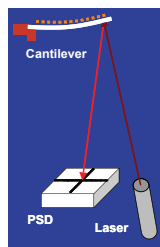
## INTRODUCTION



Micro-fabricated cantilevers are 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 micro-injection molding technique to fabricate different polymer cantilever arrays with dimensions in the micrometer range to be functionalized and calibrated for biomedical applications.

## CANTILEVER SENSORS

Micro-cantilevers respond to factors ranging from changing mass to local temperature variations. Arranged in an array cantilevers can be used as references and several experiments can be performed simultaneously.

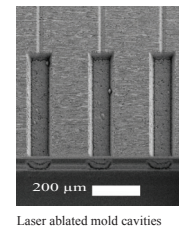
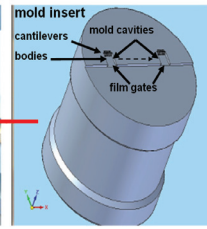
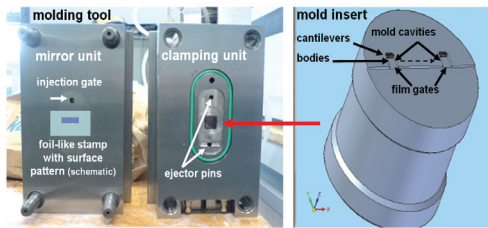


Static mode:  
compressive and tensile  
surface stress

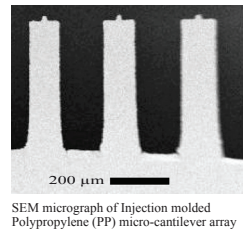


Dynamic mode:  
resonance frequency  
decreases as masses  
adsorb

## FABRICATION



Laser ablated mold cavities

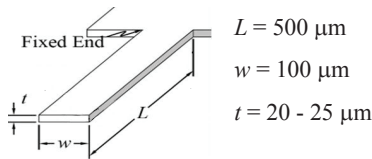


SEM micrograph of Injection molded Polypropylene (PP) micro-cantilever array

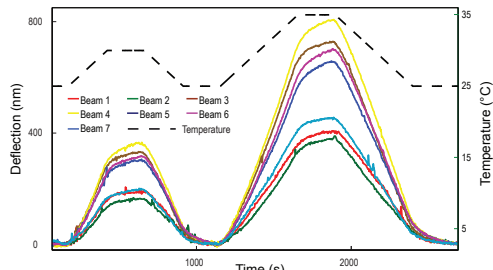
Variotherm micro-injection molding using a precisely machined, laser-ablated high-quality steel mold was applied for the fabrication of the polymeric micro-cantilevers. They are further coated with 4 nm Cr and 20 nm Au on one side for laser reflection and functionalisation.

Injection molding process parameters for the different polymers used

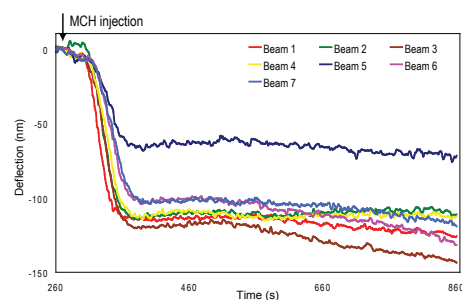
Parameters / Material	COC	PP	PEEK	POM-C	LCP	PVDF
Melting temperature [°C]	240	200	400	220	300	220
Tool temperature [°C]	77	40	225	120	150	120
Tool insert temperature [°C]	-	-	260	-	-	-
Injection speed [cm <sup>3</sup> /s]	30	9	10	10	10	10



## CHARACTERIZATION



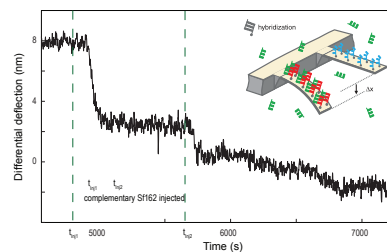
Heat test (bimetallic effect) of gold coated 22 μm thin PP micro-cantilevers



Real time monitoring of mercaptohexanol (MCH) self-assembled monolayer formation on 22 μm thin PP micro-cantilevers coated with 20 nm gold

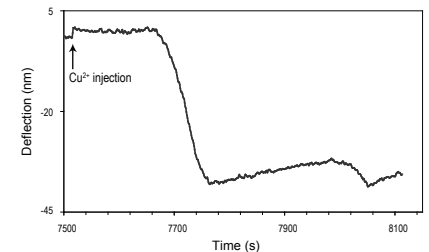
## RESULTS

Deflection of oligonucleotide (N14-3 and Sf162) functionalized cantilevers upon hybridisation of complementary Sf162 sequence was measured using the Cantisens® Research platform at 30°C with 0.42 μl/s flow of 1M NaCl buffer.



Deflection upon hybridisation of the complementary sequence

The bending of glutathione functionalized PP micro-cantilevers upon binding of divalent cations (100 μl of 0.1 μM Cu<sup>2+</sup> ions) was measured at 25°C with 0.42 μl/s flow of 100 mM NaCl buffer.

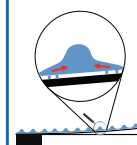


Differential signal from Cu<sup>2+</sup> ions binding to Glutathione

## CONCLUSIONS

- ✓ Injection molding permits realisation of PP micro-cantilevers with reasonable mechanical properties
- ✓ Heat tests and thiol chemisorption show characteristic behaviour of cantilevers
- ✓ Polymeric micro-cantilevers are sensitive surface stress monitors shown by thiol chemisorption
- ✓ DNA sequence recognition along with ion sensing is an important step towards biosensing

## OUTLOOK



- Quantify the cell-material interactions and molecule adsorption for biosensing
- Study nano- and micro-structuring on cantilever sensitivity
- Explore chemical biosensing with polymeric micro-cantilever arrays

## ACKNOWLEDGEMENTS

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