Polymer microcantilevers for water quality monitoring

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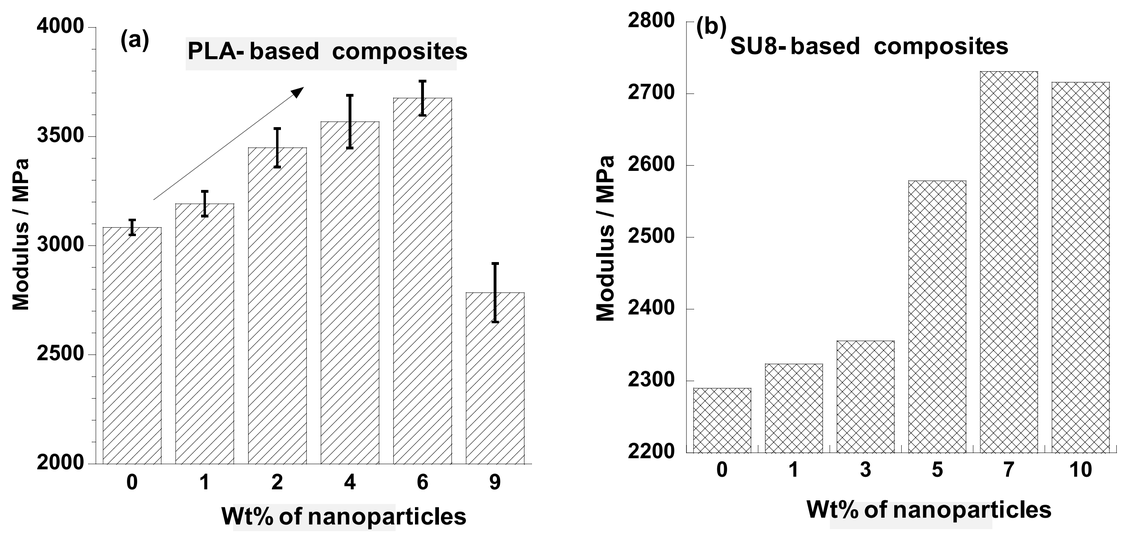
INTRODUCTION

The microcantilever project aims to develop novel polymer based microcantilevers able to detect *E.coli* in water samples for use as a rapid diagnostic for on-site water quality monitoring.

The development process is divided into four areas: Materials development, manufacturing, functionalisation and sensing.

Materials development

The stiffness of polymeric materials can be tailored within a given range, using abundantly available nanoparticles. Depending on the intended microcantilever fabrication method, polymer nanocomposites based on either thermoplastics, e.g. polylactide (PLA) (for injection moulding processes) or thermosets, e.g. SU8 (for photolithographic processes), can be developed.



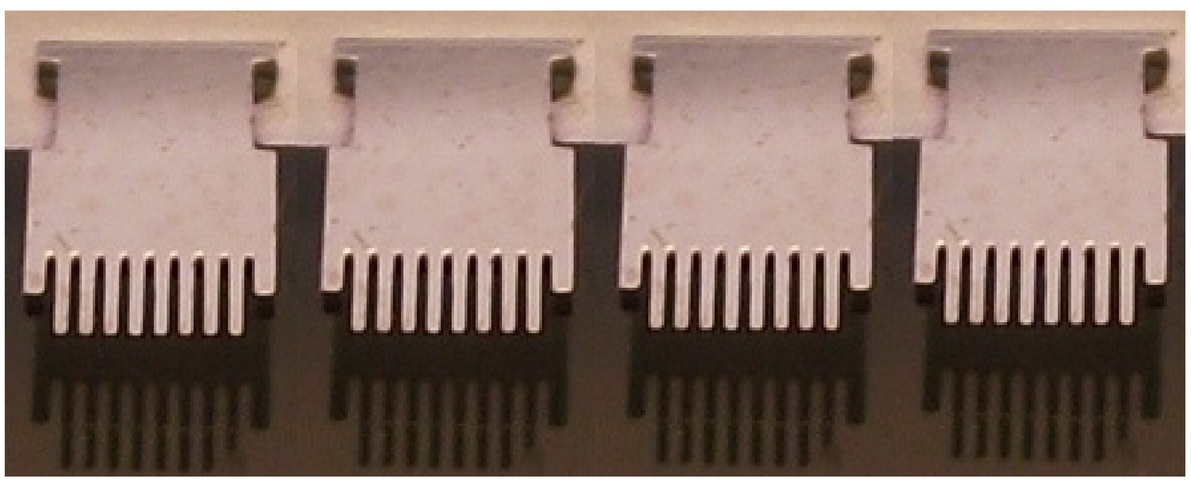
The graphs show dependence of (a) PLA and (b) SU8 nanocomposites' stiffness on nanoparticle loading

Manufacturing

There are different methods to manufacture cantilevers:

- **Micro injection moulding**
- **Photolithography**
- **Micro casting**
- **Micro machining**

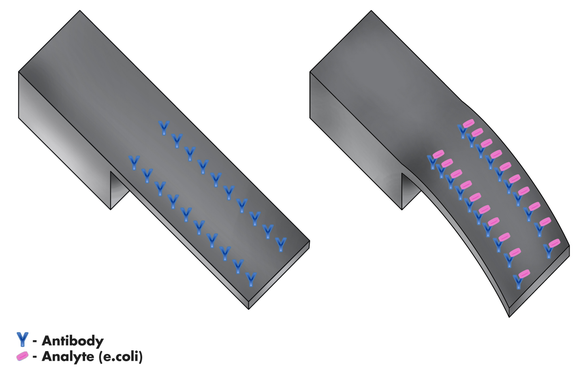
The best results have been achieved with photolithography, although tests with micro injection moulding are continuing.



Microcantilever arrays – each gold coated array has 8 cantilevers and each cantilever is 500x100x10µm

Functionalisation

Once a cantilever has been manufactured, the process requires that it is gold coated on one surface and functionalised with *E.coli* antibodies. When a bacterium binds to the antibody this results in stress on the functionalised surface of the cantilever, causing the cantilever to deflect due to the bi-material effect. The binding also adds mass to the cantilever, decreasing the resonant frequency [1].



Left: Cantilever coated with antibodies
Right: Cantilever deflected due to presence of analyte bound to antibodies

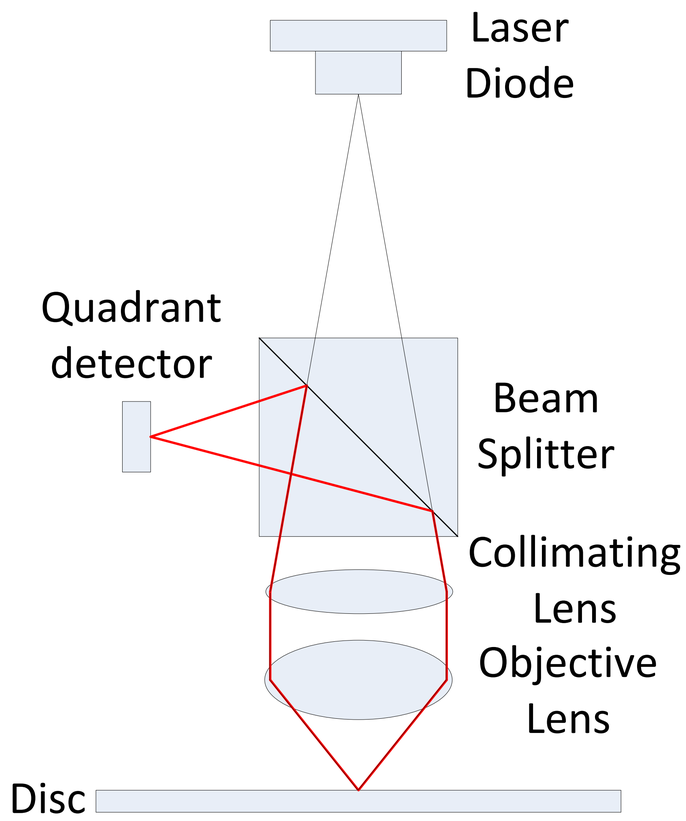
A functionalised cantilever before and after analyte binding

Sensing

There are two parameters that can be sensed, namely:

- **Deflection** of the cantilever due to the bimaterial effect
- **Resonant frequency** changes due to added mass

Both of the above parameters may be sensed using optical methods. The most promising method is to use a commercially available DVD head and modify it for the purpose of cantilever deflection and resonance sensing.



CD/DVD Pickup principle [2]

[1] Fritz J., Cantilever Biosensors, Analyst, 133, 855–863, (2008)
[2] Bosco, F. et al, High throughput label-free platform for statistical bio-molecule sensing, Lab Chip, 11, 2411 – 2416, (2011).