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# A 16-microcantilever array sensing system for the rapid and simultaneous detection of analyte

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ABSTRACT

We report on a new 16 microcantilever sensor system for performing sensing experiments in liquid or gas. The system uses two 8-microcantilever arrays that are held in a sensor cell. The microcantilever deflections are monitored by oscillating two focused optical beams over the microcantilevers such that only one microcantilever is illuminated at one time and each microcantilever is illuminated approximately once per second. The optical beams are moved using a motorized translation stage. The reflected optical beams are detected by a two-axis photo-sensitive detector (PSD) producing a series of two eight peak shaped patterns. The raw data from both the PSD and the translation stage are used to fold the peak shaped patterns from each array one on top of the other so that the deflection of the cantilevers can be obtained from the change in height of each peak. The stability of the data was found to be highly dependent on the speed of the translation stage. When the translation stage was operated between 0.5 and 1 mm/s, the deflection of each microcantilever in units of surface stress was found to be highly reproducible and consistent between arrays. As a proof-of-purpose application, the system was used to detect $Ca^{2+}$, $Sr^{2+}$ and $Cs^{+}$ ions using different calix[4]arene-based sensing layers. The results obtained were found to be reproducible and completely consistent with results obtained using a typical two single microcantilever sensor set-up.



## 1. Introduction

The advent of the atomic force microscope (AFM) has led to the use of microcantilevers as transducers capable of detecting numerous biological, chemical and physical phenomena [1,2]. Microcantilever sensors possess several advantages over other types of sensors such as high sensitivity, cost-efficiency, fast response time and the ability to be implemented in sensing arrays. As a result, microcantilever sensors have been successfully applied in many proof-of-purpose applications including cancer detection [3], detecting the human immunodeficiency virus (HIV) [4,5], drug development [6], monitoring changes in pH [7], detecting gases from explosives [8], DNA hybridization [9], and studying antigen-antibody interactions [10].

The main operating principle behind microcantilever sensors is based on the interaction of a sensing layer, immobilized on one side of the microcantilever, and the target analyte. The selectivity, specificity, and to a lesser extent the sensitivity are dependent on the sensing layer deposited on the microcantilever. The interactions between the sensing (or receptive) layer and the target analyte induce a differential surface stress on the microcantilever resulting in the microcantilever deflection. However, because microcantilever sensors are also susceptible to additional sources of surface stress or induced mechanical deflections due to changes in temperature, pH, and mechanical vibrations, a second microcantilever, called the *reference microcantilever*, is used. The reference microcantilever is preferably functionalized with a coating similar to that of the active microcantilever but without being capable of reacting with the target analyte. Therefore, subtracting the reference signal from the active signal allows the true value of the microcantilever deflection caused solely by the receptor/analyte interactions, to be determined. Although microcantilever sensors have the ability to detect a wide number of biological, chemical, and physical phe-

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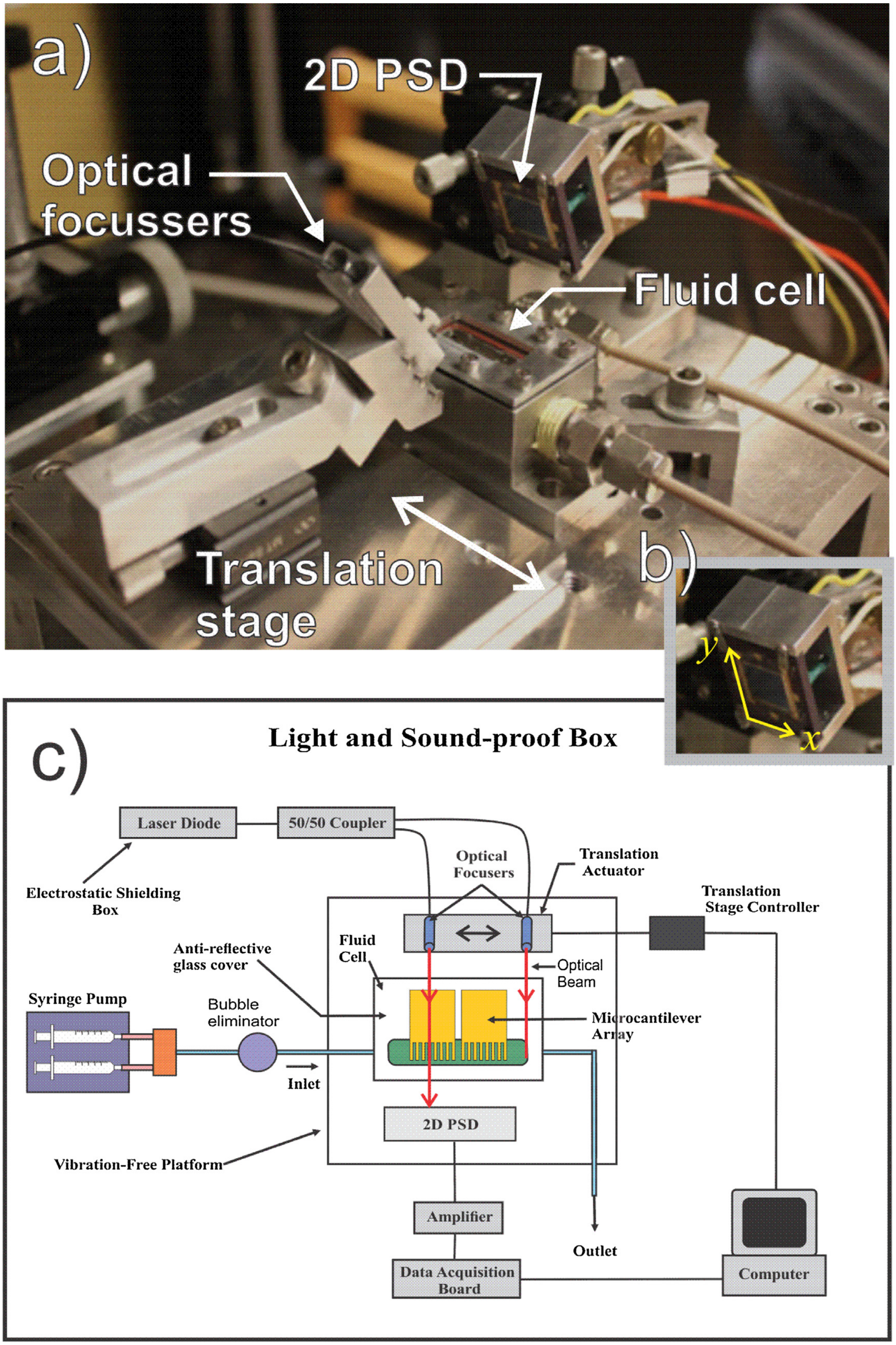


**Fig. 1.** a) A photograph of the new microcantilever array set-up consisting of a fluid cell, a holder for the optical focusers, a 2D PSD and an actuated translation stage as indicated. b) The coordinate system used in this paper to discuss the geometry of the system. c) Schematic representation of the 16-microcantilever sensor system showing all the components of the system.