MICROCANTILEVER BASED APTAMERIC NANOSensor FOR COCAINE DETECTION

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Introduction

A miniature sensor consisting of two adjacent microcantilevers (a sensing and reference pair) was utilized for detection of cocaine molecules. A cocaine-specific aptamer¹ with the sequence of 5'-HS-(CH₂)₆ - GAC AAG GAA AAT CCT TCA ATG AAG TGG GTC -3' was used to functionalize the sensing cantilever for cocaine detection while the reference cantilever were functionalized scrambled DNA sequence with same bases as aptamers. Presence of cocaine molecules was detected by measuring the differential surface stress associated with adsorption/absorption of chemical species on the sensing cantilever. The functionalized sensing and reference cantilevers were mounted in the differential surface stress sensor and exposed to different concentrations of cocaine from 0 to 500 µM in 140 mM PBS buffer (pH 7.4) to determine the sensor response as a function of the cocaine concentration. After the sensing experiments, the sensing and reference cantilevers were heated in deionized water at 80 °C to regenerate the aptamer sequence and to remove any bound cocaine molecules. The regeneration allows the sensing cantilevers to be used a number of times and each cantilevers was used for three sensing experiments. Differential surface stress developed on the functionalized cantilevers was measured as a function of cocaine concentrations in the PBS buffer. Sensor response was measured for 10 different cocaine concentrations – 0 M (pure buffer), 25, 50, 75, 100, 150, 200, 300, 400, 500 µM. At each concentration, the sensing experiments were repeated three times to assess the repeatability of the experimental measurement.

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Figure 1. Novel differential surface stress sensor²

Figure 2. Saturated surface stress values as a function of cocaine concentrations
The saturated surface stress values were recorded for each direct sensing experiment and are plotted as a function of cocaine concentration in Fig 2. Saturated surface stress increases as the cocaine concentration during the sensing experiment is increased. At the lower concentration range from 25 to 100 µM, surface stress values increase almost proportionally with concentration. However, as the cocaine concentration is increased beyond 100 µM, the surface stress values demonstrate a weaker dependence on the cocaine concentration. Based on above results and a sensitivity of 2 mN/m for the surface stress measurement, the lowest detectable threshold for the cocaine concentration is estimated to be 5 µM. Experimental results presented here have demonstrated a proof-of-concept for cocaine detection with aptamer-functionalized microcantilevers at very low concentration.

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References


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