Antibody-based SAW sensor for the detection of explosives

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Introduction

One of the important analytical challenges is the fast and reliable trace detection of explosives in the context of security issues, ammunition disposal, and environmental pollution. Antibodies (Ab) are a promising tool for this purpose and the combination with a surface acoustic wave (SAW) sensor opens the opportunity of highly selective and fast, label-free detection.

Experimental

A commercially available SAW sensor (sam5 blue, SAW Instruments) was used for liquid handling and detection.

Self-assembled monolayers (SAM) of alkanethiol derivatives were prepared on gold surfaces leading to non-fouling and hydrophilic properties, due to attached polyethylene glycol (PEG) residues.

Terminal amino groups were functionalized with trinitrophenyl (TNP) groups by reaction with trinitrobenzene sulfonic acid (TNBS).

A continuous flow of buffer (phosphate-buffered saline, PBS plus Tween 20) of 100 µL/min was applied to the sensor system. TNT antibodies were pre-incubated with the samples containing TNT antibodies were pre-incubated with the samples containing 0.5 µg/L of TNT. A complete measuring cycle needed 19 minutes including a surface regeneration step with 50 µL of acetonitrile/water/propionic acid (50:50:1) and 150 µL of SDS solution (0.1 %, pH 1 with 100 mM glycine and 100 mM NaCl).

Results

In less than 1 minute, a good signal response was obtained. 50 µL of sample was used. No non-specific interaction with the SAM surface was observed. A complete measuring cycle needed 19 minutes including a surface regeneration step with 50 µL of acetonitrile/water/propionic acid (50:50:1) and 150 µL of SDS solution (0.1 %, pH 1 with 100 mM glycine and 100 mM NaCl).

A good long-term stability could be shown for at least 6 hours. Two polyclonal antibodies (R1, R2, affinity purified with Protein A) and a monoclonal antibody (A1.1.1) were tested successfully.

Cycles with R1 pAb R2 pAb mAb A1.1.1

The limit of detection (LOD) was determined to 0.5 µg/L for all three antibodies (3s from 12 replicates).

Conclusions

A robust and sensitive method for the detection of the explosive trinitrotoluene (TNT) was developed. The detection limit was determined to be around 0.5 µg/L. The fast signal response of less than 1 minute shows that this approach is suitable for security and other time-critical applications. In addition, the very low cross-reactivity highly reduces the number of false-positives in relation to competing techniques, including sniffer dogs. Due to the multianalyte ability of the SAW system, several explosives might be detected in parallel.

References
