Bead-Based Sensors

Magnetic and optically active microspheres as chem-bio sensors

Overview

Terrorism has been called “war in the 21st Century”. There is clearly a need for a rapid, accurate, threat vector detection platform that can handle many threats, sample types and physical scales (nano-to-macro, NTM). Yet detection methods that are conventionally or currently relied upon seek to extend the traditional effort rather than develop the new methods that this new world situation requires. What is required is a new agent identification solution, capable of quickly detecting multiple threats, and a new metric to quantify the effectiveness of the new required solution. Metrics must also be adopted that allow the quantization of not only the sensitivity but the time to identify (TTI) a change in a threat state and the system design tradeoffs that weight the time to make an accurate identification with the threat detection level.

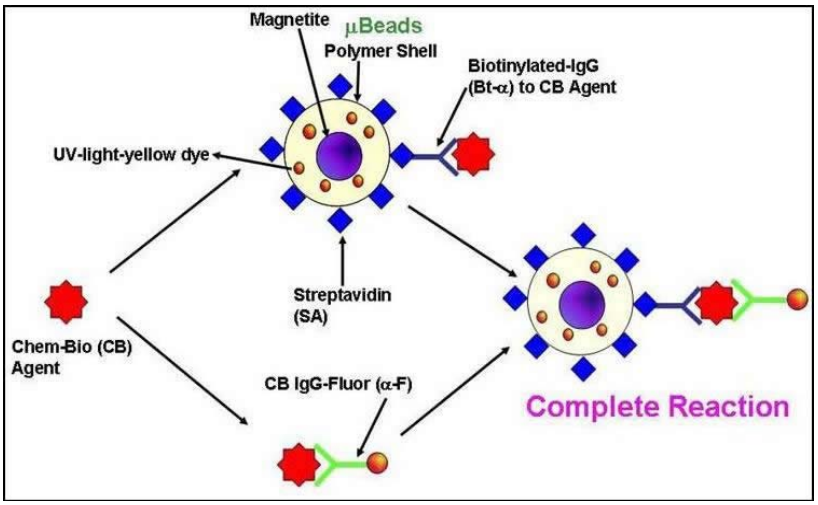

Figure 1. Bead 1.

Bead 1

Our crucial platform elements are sets of specialized beads and bead-handling and sensing components. Elements defining the TTI and multiplexed detection are described:

Bead: Each bead contains a magnetic core to permit trapping for sample cleanup and concentration. Bead surfaces are modified with Analyte Specific Reagents (ASRs). ASRs may be antibodies or oligonucleotides for selective analyte capture, while an internal Quantum Dot (QD) or chromophore dye facilitates barcoding.

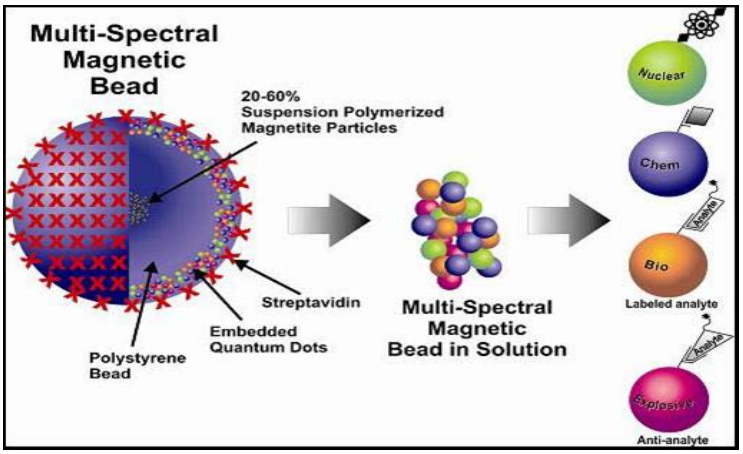

Figure 2. Bead 2.

Bead 2

Collection: The sample is collected and pre-concentrated using magnetic concentration methods for large liquid samples. An air collector for the airplane cabin air sampling may be substituted. In this case the liquid concentrator is a subsystem in the air collector sample handling system. In this system there is a reduction from gas to liquid producing a large increase in analyte concentration.

Binding: A population of ~105-107 beads containing subpopulations with different ASR coatings is introduced into the sample along with a solution containing fluorescently tagged ASR reporters. While in the binding (mixing) chamber analytes are bound to their receptors on the bead surface and to the ASR reporters, completing a sandwich that provides an optical signature of the captured analyte.

Trapping: The beads (with bound analytes) are magnetically controlled. The beads are trapped while the rest of the sample is washed away. This serves to concentrate the beads and reduce background noise.

Sensing: Beads carrying an analyte are sensed by detecting the presence of the ASR reporter. Analyte bound beads are then interrogated for the QD barcode. Beads that have both the ASR reporter and the QD barcode are identified as positive for the specific captured analyte.

The results for detecting Ovalbumin as a simulant for botulinum toxin A (BoNT/A) in raw milk are shown below.

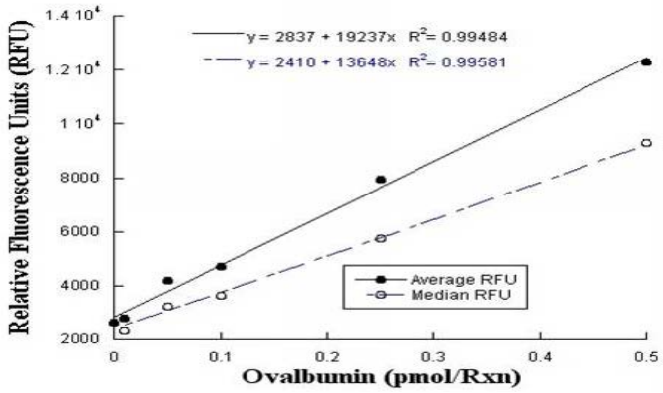

Figure 3.

For additional information or questions, please email us at BioNano@sandia.gov.

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