Encoded Metallic Nanowires Reveal Bioweapons

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When dangerous infectious diseases or biological weapons are suspected, fast help is required. The first step is a reliable, sensitive, and unambiguous, yet also fast and simple, identification of the pathogen; preferably, this test should be carried out on the spot, not in a laboratory.

Portable miniature biodetection systems that can detect multiple pathogens simultaneously would be ideal for this task.

American researchers from Lawrence Livermore National Laboratory led by Jeffrey Tok, in collaboration with groups at Stanford University, University of California at Davis, and Oxonica Inc. (formerly Nanoplex Technologies Inc) have now developed a new basis for such a multiplex device: they are using silver and gold “striped” nanowires as supports for simultaneous immunological tests for various pathogens. Individual patterns of stripes act in the role of “barcodes”.

These “nanobarcoded” particles are manufactured by Oxonica Inc using template-assisted electrochemical deposition of metals within the tiny cylindrical pores of alumina membranes. When deposited gold and silver are alternated in a defined way, nanowires with different characteristic stripe patterns are produced. The pattern of optical reflections from each sequence of stripes can later be unambiguously recognized—just like a barcode.

Antibodies aimed at specific pathogens can be attached to these wires. For their test runs, Tok and his colleagues selected harmless model

substances to stand in for anthrax spores, smallpox virus, and protein toxins such as ricin and botulinum toxin. If a simultaneous test for all of these is desired, the anthrax antibody would be attached to stripe pattern 1, the smallpox antibodies to stripe pattern 2, and the toxin antibodies to stripe pattern 3, for example.

If the corresponding model pathogen is present in a sample, it is "recognized" and bound by its antibodies. At this point, free antibodies that have been tagged with a fluorescent dye are added to the sample. These also dock onto the pathogen so that it is surrounded like the filling in a sandwich; giving the technique its name, "sandwich immunoassay". Measurement of the fluorescence now gives information about the pathogen concentration. Analysis of the reflection pattern allows the "barcode" of the fluorescing nanowires to be read.

If only wires with stripe pattern 1 fluoresce, for example, then the sample contains anthrax spores. One particular advantage of nanowires over other antibody supports is that the tests do not take place at a surface but instead in a suspension, which makes them run much faster and more accurately. If nickel stripes are also added to the ends of the wires, they can then be magnetically separated out during the required washing steps—a prerequisite for a portable microbiodetector.

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