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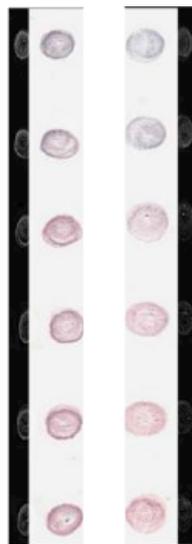
TECHNOLOGY UPDATE

May 21, 2003

Nanoparticle sensor 'blushes' in presence of lead

Scientists from the University of Illinois at Urbana-Champaign, US, have made a DNAzyme-gold nanoparticle sensor that changes colour when lead ions are present. The technique could be used to detect lead in paint and other environmental contaminants.

"The design of metal-ion sensors has long been a focus of research endeavours because it can provide on-site, real-time detection of both beneficial and toxic metal ions in applications such as household and environmental monitoring, developmental biology and clinical toxicology," researcher Yi Lu told *nanotechweb.org*. "Most reported sensors are fluorescent and few highly selective colorimetric metal sensors are known. Our simple colorimetric sensor can eliminate or minimize most of the costs associated with fluorescence detection."



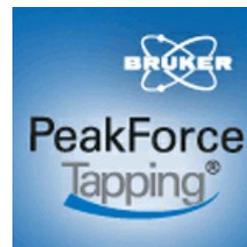
Red means lead

The sensor consists of 13 nm diameter gold nanoparticles linked to thio-modified DNA, the 17E DNAzyme and the DNAzymes' substrate. DNAzymes are DNA molecules with enzymatic activity; they are also known as catalytic DNA or deoxyribozymes. The DNAzyme substrate chosen in this case hybridizes to a gold nanoparticle at each end, causing the nanoparticles to aggregate into clusters with a characteristic blue colour. But in the presence of lead ions the DNAzyme catalyzes the cleavage of the substrate, preventing the nanoparticle aggregates from forming and producing a red colour. The intensity of the red colour depends on the concentration of the lead ions.

The sensor is not affected by the presence of other metal ions such as magnesium, calcium, manganese, cobalt, nickel, copper, zinc or cadmium. However, a combinatorial biology approach called *in vitro* selection can produce DNAzymes that are highly specific for other ions.

"[This technique] will significantly expand the scope of nanoparticle biosensors to essentially any analyte of choice, because *in vitro* selection can be used to select DNAzymes that are active in the presence of any desired analytes or concentrations," added Lu.

The scientists also found that they could tailor the sensitivity of their lead sensor over several orders of magnitude by introducing a proportion of inactive DNAzymes. For example, an unoptimized sensor detected lead ions with a concentration of 100 nM up to 4 μM, but with inactive DNAzymes present it detected in the range 10-200 μM.



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According to Lu, the DNAzyme-nanoparticle sensors could have applications in detecting lead, mercury or other toxic metal ions in the household, swimming pools or playgrounds; environmental monitoring; clinical toxicology; industrial process and waste-disposal monitoring; and the monitoring and assessment of (bio)remediation of contaminated sites.

"Many old houses around the world contain leaded paint," he said. "According to the US Environmental Protection Agency, the leaded paint test kits currently available showed high rates of false positive and false negative results when compared with laboratory analytical results. The new DNAzyme-nanoparticle sensor can overcome many of these shortcomings and promises to offer a simple leaded paint test kit, similar to pH papers."

Now the scientists plan to make sensors for other metal ions such as mercury, chromium and arsenic, create sensors for toxin molecules and aromatic pollutants, and design colorimetric sensor kits. They reported their work in the *Journal of the American Chemical Society*.

About the author

Liz Kalaugher is editor of *nanotechweb.org*.

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