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Dipstick test detects lead in paint

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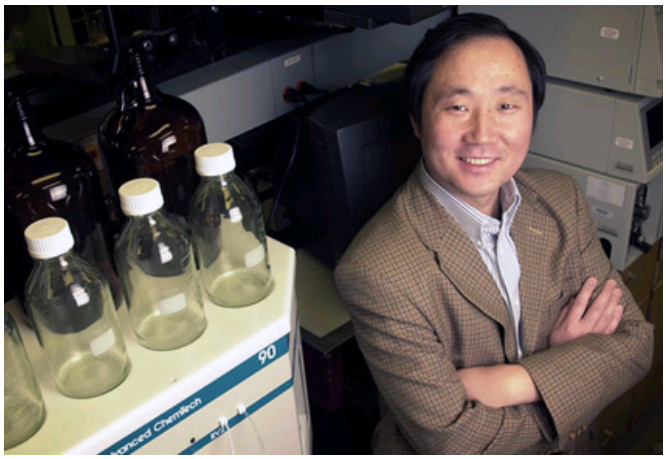
Tags: aptamers, biochemistry, biosensors, catalyst, deoxribozymes, DNA, DNAzymes, enzyme, EPA, gold nanoparticles, lead detection, metal ions, toxicology, University of Illinois

U. ILLINOIS (US)—Yi Lu took another researcher's discovery about a new way to achieve catalytic reactions and turned it on its head—developing a simple, low-cost lead paint detection method for home and official use.

In 1994, Lu read in *Chemistry and Biology* magazine a seminal work by Ronald Breaker and Gerald Joyce about a new method of using metal ions to turn DNA into an enzyme to catalyze chemical reactions.

He wondered what would happen if the process were reversed.

"We asked 'can we actually turn DNAzymes that bind to a metal ion like lead or mercury into "reporters" for the presence of metal ions?'" says Lu, a researcher at the University of Illinois's Beckman Institute.



In a recent paper published in Chemical Communications, Yi Lu and his collaborators report that they have fashioned a viable, easy-to-use dipstick test that, unlike other methods, requires no instrumentation or laboratory work and that meets EPA guidelines for lead detection. The dipstick test shows a color change to red when lead is detected at one milligram per square centimeter and has been shown to be effective even if the lead-based paint has been repeatedly painted over. (Credit: U. Illinois)

So Lu leveraged his laboratory's previous work on how different metal ions can help DNA function and flipped the direction to see if the DNA enzymes, or DNAzymes (deoxribozymes) as they are called, can help detect metal ions. The research line proved so successful that it led to the creation of dipstick test prototypes for detecting toxic metals.

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The Lu group had previously reported using cross-linked gold nanoparticles and aptamers, DNAs that bind many targets, in a lateral flow device—also known as a dipstick test and similar to commonly used home pregnancy tests—to create colorimetric biosensors for detecting molecules such as cocaine.

The biosensors were highly sensitive and accurate, but it was difficult to apply the method to DNAzyme-based sensing of metal ions due the difficulty in controlling DNAzyme catalytic activity and product release.

Lu's recent paper reports on an advancement in which the researchers used non-cross-link DNAzyme–gold nanoparticle conjugates to create a hybridization method for detecting lead that is stable at ambient conditions for long periods of time.

The sensor is able to detect trace levels of lead that more than meets EPA requirements.

The dipstick test shows a color change to red when lead is detected at one milligram per square centimeter (the level paint is deemed to be lead-based), and has been shown to be effective even if the lead-based paint has been repeatedly painted over.

The researchers write: "Designing easy-to-use biosensors for trace metal ions in the environment is of considerable importance as these metal ions are large in number, small in quantity and high in toxicity."

They add that their DNAzyme–gold nanoparticle non-cross-link method, as applied in a dipstick test, "will find wide use in household and other environmental applications."

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