SERS-based assays a simple and convenient method to monitor glucose levels

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A new metal carbonyl-based assay has potential as a clinical diagnostic tool and offers several advantages over current monitoring of sugars in urine samples. Credit: moodboard/Thinkstock

Diabetes is a major health problem that affects 371 million people worldwide, and a high blood glucose level is one of many complications associated with diabetes and pre-diabetes. Malini Olivo at the A*STAR Singapore Bioimaging Consortium and co-workers have now developed a highly sensitive and specific surface-enhanced Raman scattering (SERS)-based assay to detect glucose in urine.

SERS-based assays represent a simple and convenient method to monitor glucose levels in urine. The technology uses organometallic compounds as 'sugar receptors' for sensing glucose and a gold–silver substrate for

enhancing signals from these receptors. Most such sugar receptors, however, have a low detection limit and specificity. They often require samples to be purified prior to testing and may not be able to distinguish glucose from similar sugars such as fructose and galactose. As a result, SERS-based assays are not yet an accessible and dependable solution for monitoring glucose levels in patients with diabetes.

Searching for a more effective test, Olivo and team developed an assay which uses triosmium carbonyl conjugates as sugar receptors and an in-house fabricated material—bimetallic film over nanospheres (BMFON)—as the signal-enhancing substrate. They found that the metal carbonyl conjugates selectively bind simple sugars and produce a unique absorption peak for glucose at 2111 centimeters–1, which lies in the so-called 'silent' mid-infrared region of the SERS spectrum between 1800–2200 centimeters–1. The intensity of the peak varies with glucose concentration and can be used to measure glucose quantities. In addition, BMFON enhances the signal intensity to extend the limit of detection to 0.1 millimoles of glucose per liter to cover a range that includes the physiological glucose concentration of 5 millimoles per liter.

Using their newly developed assay, the researchers could determine the glucose level in urine samples spiked with a standard glucose solution. The new assay has three key advantages: only a low sample volume is required; there is no need for the sample to be purified; and the assay's sugar receptors do not need to be conjugated to SERS-active nanoparticles.

"Our work is unique in that we used a metal carbonyl probe to access an uncluttered region in the SERS spectrum, which most other organic probes cannot provide," says Olivo. "By coupling this probe to a SERS-based assay, we achieved a high selectivity and sensitivity in the detection of glucose over other sugars."

"These advantages should mean that this concept for a glucose assay can be developed into a clinical diagnostic tool," says Olivo.

More information: Kong, K. V., Lam, Z., Lau, W. K. O., Leong, W. K. & Olivo, M. "A transition metal carbonyl probe for use in a highly specific and sensitive SERS-based assay for glucose." *Journal of the American Chemical Society* 135, 18028−18031 (2013). dx.doi.org/10.1021/ja409230g

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