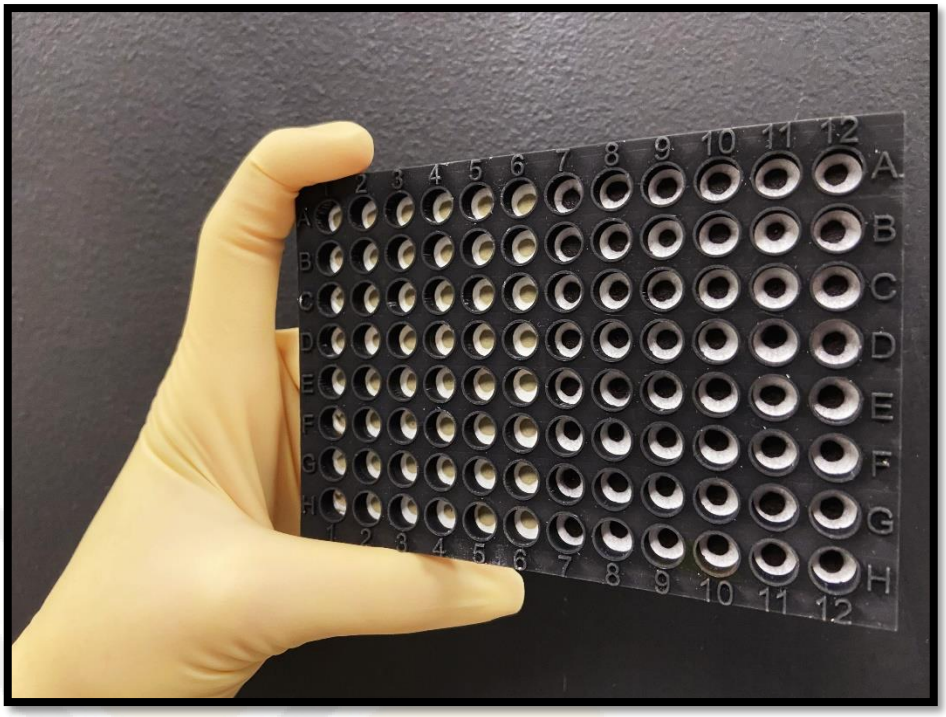
DRUG DETECTION

APPLICATION NOTE



SERS MICROPLATE:
DRUG DETECTION IN SALIVA

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KEYWORDS

ILLICIT DRUGS

Morphine and methamphetamine concentration sensing.

MICROPLATES

High-throughput spectroscopy for faster detection

SERS

Non-destructive detection of narcotics in saliva

High throughput applications are sought out to increase the efficiency of automated parallel or automated sequential sample preparation and analysis. An essential application requirement is the ability to achieve rapid analysis and high throughput with a small sample volume. Microplate technology is closely associated with high throughput analysis and is often implemented for fast and reliable testing of biological reagents.

Microplates are characterized as having an array of many wells to increase the number of tests that can be performed. Microplates differ by many aspects; among them size, color, and density are important factors. The most common usage of the microplate is ELISA (enzyme-linked immunosorbent assay), which is a type of immunoassay that works by using antibodies to detect substances. However, the assays are labor intensive, time consuming, and require trained physicians in a lab setting.

Here, our high throughput SERS microplate has proven to be a promising technology as an easier and more convenient method of analyzing a large scale of samples. The desire for high sample throughput is allied with a SERS 96-well plate designed and created in-house, to enhance sample production and reduce the operation time. Control over the design architecture of the SERS microplate is crucial as it affects the overall performance of an assay.

ILLICIT DRUG SENSING

RAPID PARALLEL TESTING IS ESSENTIAL

Over the past few years, there has been a considerable increase in the abuse of illicit drugs, as well as death cases.[1] It is a field of interest to detect these drugs due to the consequences of misuse on the physical and mental health of individuals.[2]

Our SERS microplate is a rapid method for non-invasive and highly sensitive detection of illicit drugs in saliva. Experimental time is reduced to minutes using an array of Ag and Au colloidal nanoparticles.

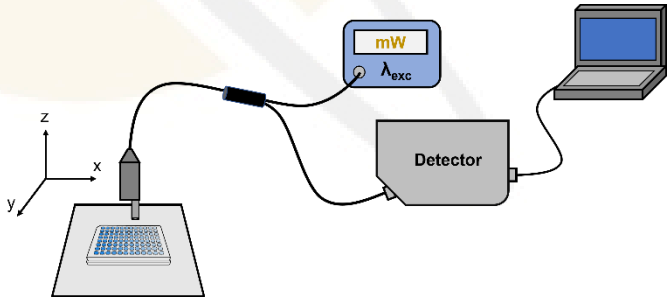
In contrast with other body fluids, saliva allows a faster, simpler, and more controllable sampling.[3] Also, drugs are found to have a similar concentration in saliva and blood plasma, considering that saliva is 99.5% of water, which makes it simpler to analyze.[3]

Illicit substances such as methamphetamine and morphine are used in the study and the method used allowed the detection and identification of them.

APPLYING THE SERS MICROPLATE

NON-INVASIVE SERS DETECTION IN SALIVA

- ✓ **If possible, incorporate a x-y-z translation stage to make moving from well to well faster, easier, and more precise.**
- ✓ **Use the alphanumeric labels to readily identify the "address" of a specific sample.**
- ✓ **Try performing SERS experiments using both silver and gold nanoparticles.**
- ✓ **Avoid using laser powers greater than 10 mW when experimenting with artificial saliva.**
- ✓ **For better results, 7-10 µL of the sample solution is recommended.**



Schematic of high throughput SERS measurements scanned on the x-y-z translation stage. SERS were carried out using an Ocean Insight 785 nm QE Pro Raman system. A 10 µL sample was added to the microplate well and allowed to dry before laser excitation. The samples were interrogated at 7.5 mW laser power and 3-5 second integration time. For comparison tests, the samples were collected under the same criterium.

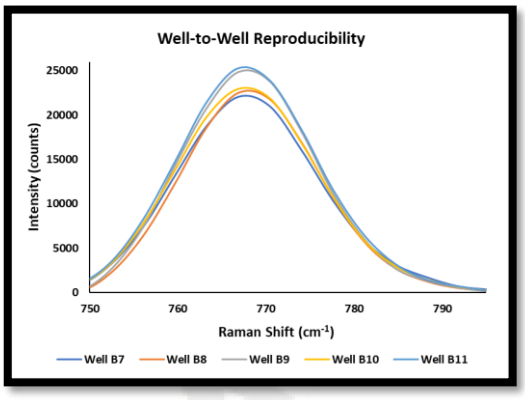


Figure 1. SERS signal from 5 wells for one concentration of R6G in EtOH.

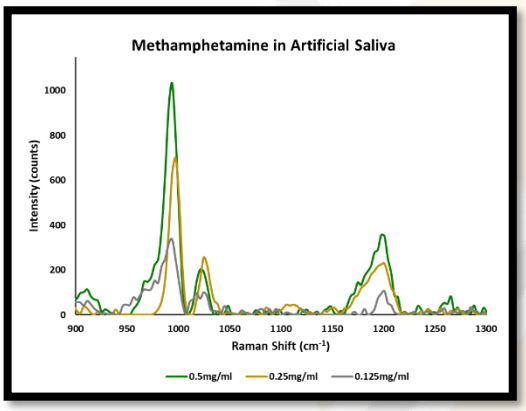


Figure 2. SERS signal of three different concentrations of methamphetamine in artificial saliva showing increased signal with higher concentrations.

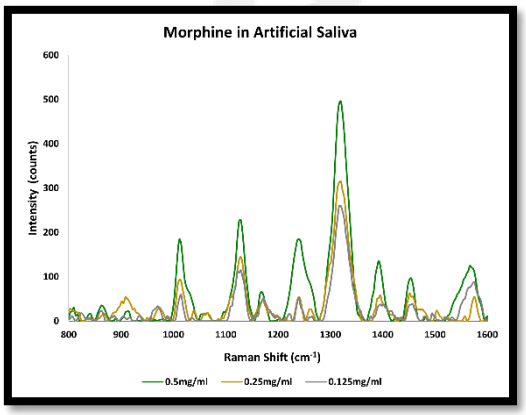


Figure 3. SERS signal of three different concentrations of morphine in artificial saliva showing increased signal with higher concentrations.

SERS SIGNAL

WELL-TO-WELL REPRODUCIBILITY

Rhodamine 6G molecule diluted in ethanol at a concentration of 1 mM was collected in the same criteria for five Au-active wells. A 2 second integration time was used at 7.5 mW laser power. The appearance of the high intensity SERS signal corresponding to the R6G molecule was 766 cm^{-1} and also validates that this molecule is adsorbed on the surface of the SERS active microplate in the Au region. Results indicate that the variation of the intensity (counts) of the Raman bands presented is 6.1 %. Therefore, the signal strength of the R6G peak was relatively consistent.

METHAMPHETAMINE IN ARTIFICIAL SALIVA

Methamphetamine in artificial saliva was measured at 5 s integration time and 7.5 mW power for all three concentrations in Au active well. Raman shift is detected at 994 cm^{-1} and 1201 cm^{-1} and shows an increase in the intensity in counts with increasing concentration.

MORPHINE IN ARTIFICIAL SALIVA

Morphine in artificial saliva was collected on a 5 s integration time and 7.5 mW laser power for all three concentrations at the Ag active wells. An increase of 1101 cm^{-1}, 1125 cm^{-1}, 1320 cm^{-1}, 1132 cm^{-1}, 1392 cm^{-1}, and 1454 cm^{-1} peaks are observed according to the growth in the concentration.

CONCLUSION

Our microplate has demonstrated the ability to sense the variation in concentration. It has also demonstrated good uniformity and reproducibility on the substrates of each well to another by 6.1 %, as well as the technique to place the nanoparticles in the microplate. The capacity to test a relevant drug experiment with body fluid was successfully achieved.

The potential of high throughput SERS spectroscopy in our microplate is very promising as it can be used for a multi-assay analysis of biological tests giving rapid results of the samples.

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