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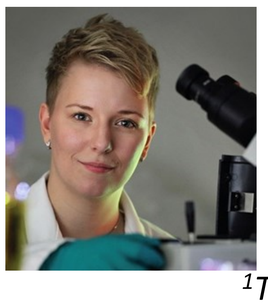

Surface enhanced Raman spectroscopy (SERS) sensing in aqueous sample enabled by UV/ ozone treatment

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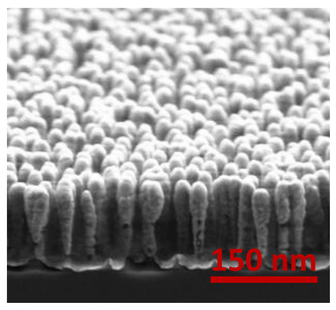
We present the development of a detection strategy based on surface-enhanced Raman spectroscopy (SERS) sensing in water. The SERS substrates, fabricated from free-standing, gold-capped silicon nanopillars are commonly used for the detection of analytes dissolved in organic solvents and dried on the sensor surface. We developed a method where detection can be performed directly in aqueous samples using a model drug acetoaminophene (Paracetamol).

SERS sensing in Water

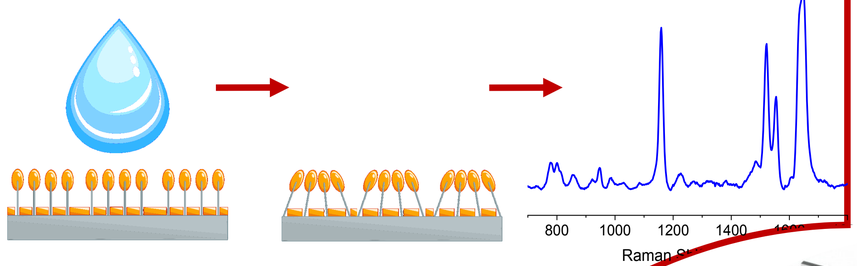
Pharmaceuticals have become integral parts of our daily life. However, this widespread availability poses a potential risk of leakage into our environment leading to possible disturbances in various eco systems. Even though low concentrations of single drugs are not necessarily harmful, cross-reactions with other drugs and accumulation can be dangerous if not carefully monitored.

SERS Substrate - Gold Capped Nanopillars

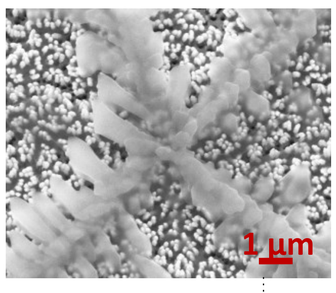
SERS is a powerful analysis technique capable of detecting molecular fingerprints of analytes with high sensitivity and fast response time. [2]



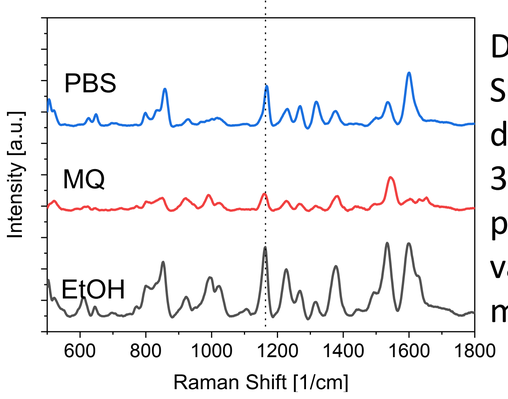
Silmeco ApS



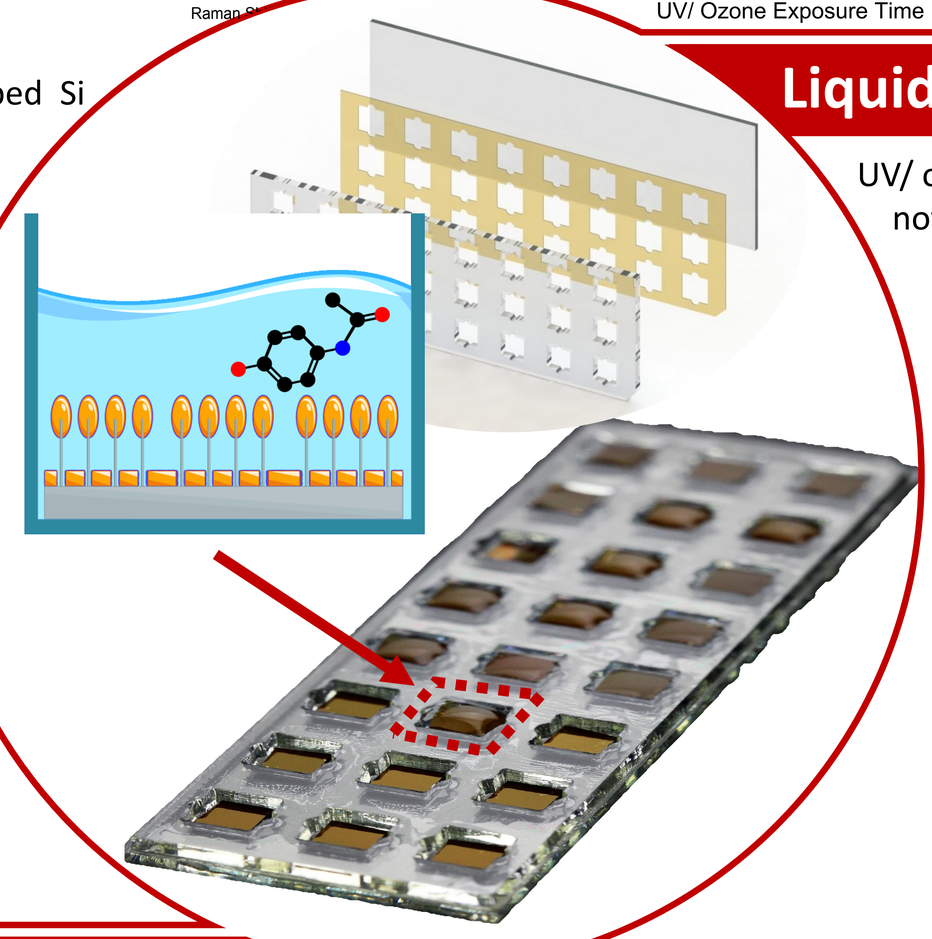
Classical dry droplet SERS sensing using gold-capped Si nanopillars. [3] Dry droplet measurements are highly Influenced by the chosen sample matrix.



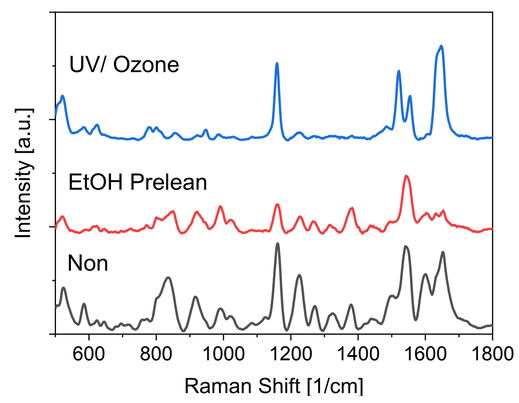
Complex matrices can lead to sensor fouling. Organic solvents are preferred, due to the **hydrophobic nature of the nanopillar** surface.



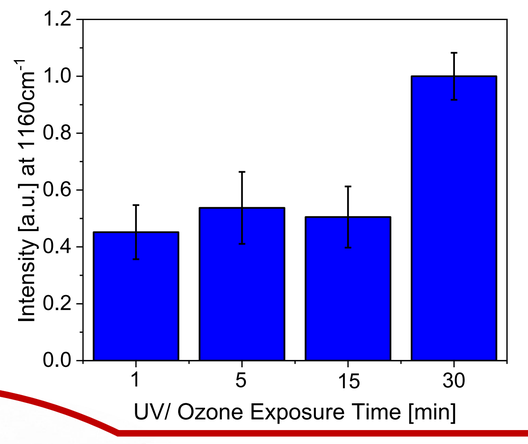
Dry droplet SERS-based detection of 350 µM paracetamol in various aqueous matrices.

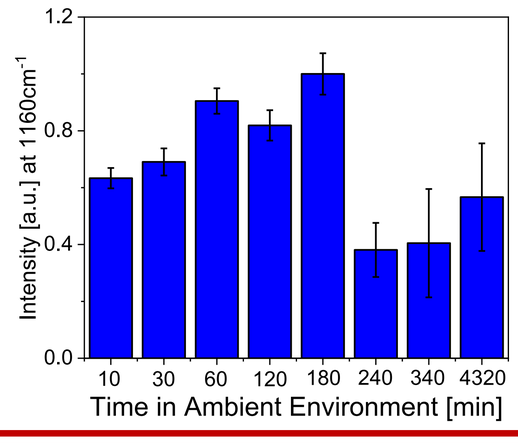


UV/ Ozone Treatment



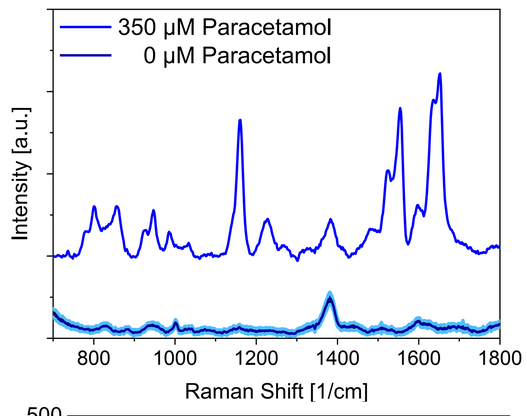
UV/ ozone surface treatment resulted in a lowered background signal, more defined peak shape and homogenous wettability in aqueous samples in comparison to untreated and pre-leaned samples. Optimal signals were obtained after **30 min** of treatment and samples were stable for **3 hrs** in an ambient environment.

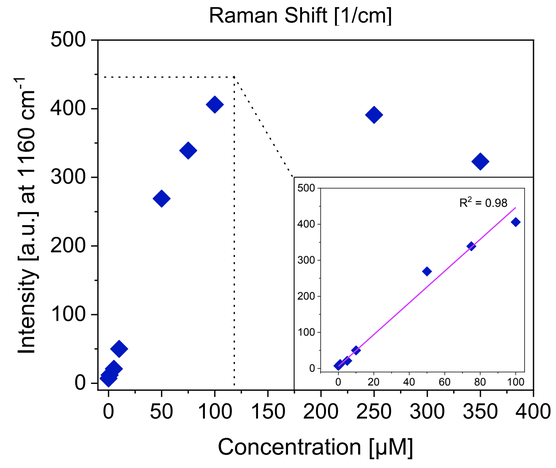




Liquid Measurements

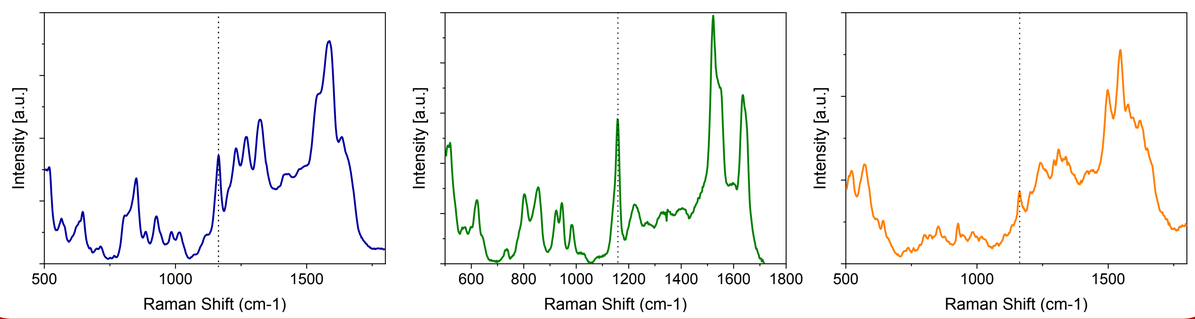
UV/ ozone treatment enabled the development of a novel liquid measurement technique for nanopillar SERS based sensing.





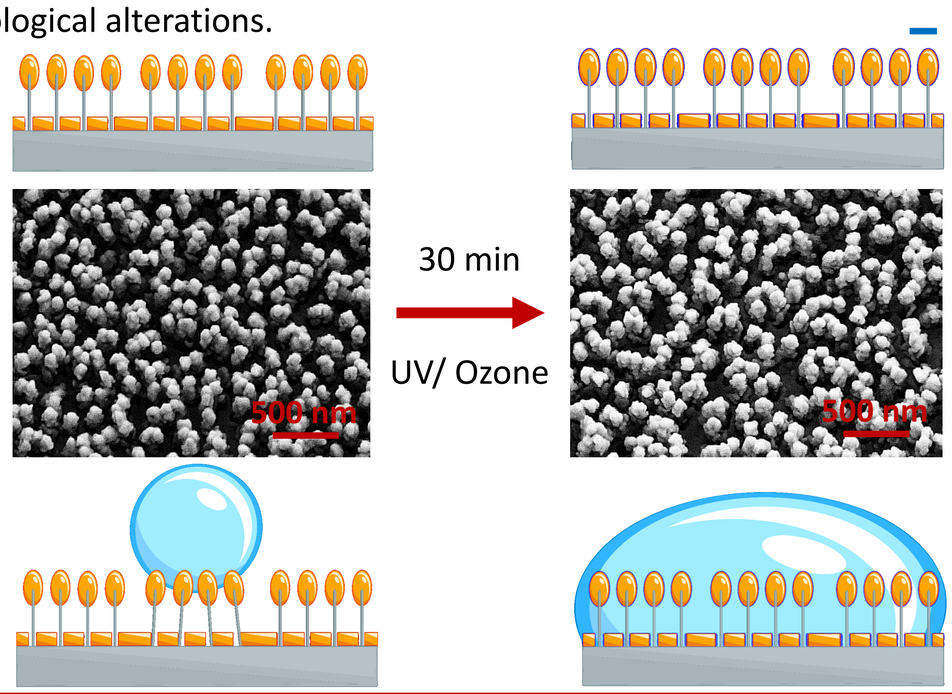
Direct Paracetamol detection in MQ was possible over a linear range of **5 – 100 µM**.

350 µM Paracetamol spiked in **PBS, tap water** and unfiltered **river** water shows that UV/ Ozone pre-treatment allows detection in a realistic environment.



Surface Treatment

UV/ ozone exposure is commonly utilized as surface treatment and cleaning procedure in a variety of microfabrication processes. It renders the surface of gold-capped nanopillars from hydrophobic to hydrophilic without any morphological alterations.



Acknowledgement

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References

[1] A. B. A. Boxall. "The environmental side fects of medication" in European Molecular Biology Organization, 2004, pp. 1110-1116

[2] G. C. Schatz, M. A. Young, and R. P. Duyne, "Electromagnetic Mechanism of SERS," in Surface-Enhanced Raman Scattering, Springer Berlin Heidelberg, 2006, pp. 19–45.

[3] M. S. Schmidt, J. Hübner, and A. Boisen, "Large Area Fabrication of Leaning Silicon Nanopillars for Surface Enhanced Raman Spectroscopy," Adv. Mater., vol. 24, no. 10, p. OP11-OP18, Mar. 2012.

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