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Integration of nanopillar SERS Substrates in Lab-on-Disc SERS Platforms for Label-Free Detection in Complex Samples

Abstract

Surface-Enhanced Raman Scattering (SERS) offers unparalleled molecular specificity and sensitivity, but its application in complex sample matrices is often challenged by signal variability and matrix interference[1–3]. Here, we present a novel lab-on-disc (LoD) platform that combines solid-phase extraction (SPE)-assisted sample preparation with a SERS substrate for robust and reproducible detection of drug in serum samples. The disc architecture enables automated fluid handling through centrifugal forces, ensuring uniform sample distribution and minimal user intervention[1]. The integrated nanopillar plasmonic substrate which is composed of silver-coated pillars can facilitate dense hotspot formation and high signal uniformity, even in biofluids. Multivariate data analysis, including principal component analysis (PCA) and partial least squares regression (PLSR), enhances the interpretability of complex spectral datasets and supports quantitative and classification tasks. The platform demonstrates detection limits in the low micromolar range for two targeted analytes as antibiotic and chemotherapy drug. This synergy between proper sample pretreatment, automated microfluidics, engineered nanostructures, and chemometric modeling provides a scalable route for point-of-care diagnostics and therapeutic monitoring in clinical and environmental settings.

References

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Figures

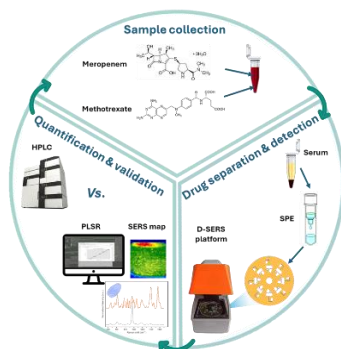


Figure 1: Workflow of SERS-based drug monitoring: sample collection, drug quantification via SERS, and data analysis.

