

AVAC: an ultrasensitive and versatile plasmonic platform for digital biomarker detection and nanoscale metrology

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The AVAC platform is a new generation of optical biosensing systems that can quantify proteins and other biomarkers at ultra-low concentrations by digitally counting plasmonic nanoparticles (Figure 1) [1]. AVAC is based on proprietary reflective dark-field microscopy [2] and image analysis algorithms [3]. It combines single-particle detection with high-throughput scanning, achieving a detection limit in the femtogram-per-milliliter range and a dynamic range spanning over four orders of magnitude.

Validation studies demonstrated excellent analytical performance, with limits of detection down to 26 fg/mL for HIV p24 and a quantification range of 0.16–850 pg/mL for interleukin-6 (IL-6), achieving precision and specificity exceeding 98 %. The same study highlighted AVAC's capability for true multiplexed assays, which enable the simultaneous measurement of cytokines and cardiovascular markers (IL-6, cTnI, and BNP) without loss of sensitivity. Thanks to its digital detection principle, AVAC provides intrinsic linearity, making it a powerful and reliable tool for translational research and clinical diagnostics.

Beyond its biosensing applications, ongoing research [4] explores using AVAC as a plasmonic nanoruler to characterize dielectric and biofunctionalized surfaces at the nanometric level. By exploiting the wavelength shifts of individual gold nanoparticles induced by local refractive-index changes, the platform can map thickness variations below 1 nm over large areas within minutes. This achievement showcases AVAC's versatility as an optical platform suitable for biomedical diagnostics and nanoscale metrology of dielectric and biofunctionalized layers.

AVAC is a technology that combines ultrasensitive digital detection, a broad dynamic range, and industrial-scale throughput, paving the way for a next-generation platform that enables both high-performance biosensing and nanoscale metrology.

References

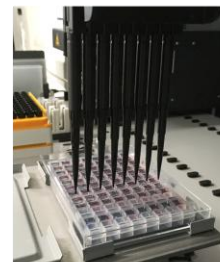
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- [2] V. Pini, A. Thon, A. Salvador-Mátar Rentería, V. Cebrián Hernando, C. García Aguado, Ó. Ahumada Heredero, *Biosensor platform and method for the simultaneous, multiplexed, ultra-sensitive and high-throughput optical detection of biomarkers*, U.S. Patent 11,519,843 B2 (2022).
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- [4] T. Muñoz-Ortiz, V. Pini, A. Thon *et al.*, *High-throughput nanoscale metrology of ultrathin inert and functionalized dielectric substrates using plasmonic nanoparticles*, submitted (2025).

Figures

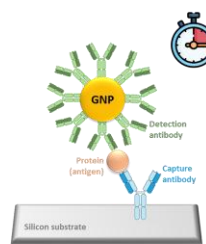
A) Substrate with superstructure



B) Assaying Procedure



C) Sandwich Assay



D) AVAC Reader



Figure 1. Workflow of the AVAC platform showing (A) substrate and superstructure, (B) automated assay procedure, (C) sandwich immunoassay principle, and (D) AVAC optical reader.