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Tentative topic of the invited talk

Point-of-Care Microfluidics for Rapid and Comprehensive Disease Diagnostics

Abstract of the invited talk

Rapid antimicrobial susceptibility testing (AST) and molecular diagnostics remain critical unmet needs in infectious disease management, particularly in low-resource environments where conventional culture-based and PCR-based assays are impractical. We report the development of complementary microfluidic and paper-based diagnostic platforms that integrate low-cost fabrication with sensitive detection strategies to address these bottlenecks. Our microfluidic AST platform incorporates carbon screen-printed electrodes within a microfluidic chamber for electrochemical impedance spectroscopy (EIS)-based monitoring of bacterial growth in the presence of antibiotics. This configuration enables real-time quantification of cell-antibiotic interactions, reducing the AST turnaround time from the standard 24-48 h to 3-6 h. The fabricated device correlates impedance changes (ΔRct) with bacterial growth, optimized using 10% Tryptone-Nutrient medium, and effectively distinguishes susceptible and resistant strains against Ampicillin and Tetracycline. It demonstrated versatility across Gram-negative and Gram-positive bacteria, validated through fluorescence viability assays. Importantly, the device reliably detected bacterial presence and drug susceptibility directly in spiked human urine samples, confirming robustness in complex clinical matrices.

We established a laser printer-based fabrication method for microfluidic paper-based analytical devices (μPADs) that enables rapid, low-cost, and scalable production. This technique precisely patterns hydrophobic barriers and provides full device enclosure with sub-millimeter resolution, eliminating the need for photolithography or lamination. The process is compatible with a wide range of paper substrates and fluidic designs, ensuring reproducibility and adaptability for both prototyping and high-throughput manufacturing. By simplifying fabrication while maintaining performance, this approach underpins our electrochemical and nucleic acid detection platforms. Building on this fabrication strategy, we developed a paper-based DNA detection system for high-risk HPV genotypes 16 and 18, targeting primary cervical cancer screening. Collectively, these platforms demonstrate how accessible fabrication, streamlined sample processing, and sensitive detection modalities can be integrated into point-of-care diagnostics capable of guiding rapid, evidence-based clinical decisions.