Trends and Opportunities in Raman Based Infection Diagnostics

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Abstract
Infectious diseases continue to be a major cause of mortality worldwide. To manage them effectively, pathogen identification, informed antibiotic selection, and assessment of the host response must be viewed as interconnected components rather than isolated tasks. Clinicians also require rapid stratification tools alongside simplified sampling procedures. Ongoing clinical research is uncovering new links between disease manifestation and easily accessible biomarkers. This knowledge is driving the development of innovative diagnostic strategies that, when combined with optimized sample preparation, sensor technologies, and data analytics, support physicians in making timely therapeutic decisions. Photonics-based diagnostic methods have already demonstrated their value for time-critical assessments and offer strong potential for point-of-care applications.
This contribution outlines recent advances in in vitro Raman-based diagnostics, tracing progress from laboratory studies toward clinical implementation. To enable seamless sample-to-answer workflows, photonic technologies must be adapted to address clinically relevant relationships between pathogen detection and host response. Blood diagnostics serve as a representative example: the Raman signature of cells is highly sensitive to variations in white blood cell composition and activation state [1–6], which are often driven by changes in the cells biochemical make up. The information embedded in these signatures can support the identification of underlying disease causes and severity.
Furthermore, Raman spectroscopy can accelerate and refine antibiotic decision-making by characterizing how bacteria respond to different

antibiotics and concentrations [7–10]. The encouraging outcomes of this research underline the importance of developing Raman-based clinical workflows and highlight their potential to significantly improve infection diagnostics.

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