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Feasibility Study of Radiofrequency Confined Plasma for Early Detection of Atherosclerosis Using Photonic Chip Platforms

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ABSTRACT

Introduction: Atherosclerosis, particularly in its earliest stage defined by the formation of fatty streaks within the arterial intima, remains a principal contributor to cardiovascular disease and morbimortality worldwide. Accurate early detection is essential, yet many existing diagnostic modalities are invasive, costly, or insufficiently sensitive to detect subtle biochemical disturbances or functional abnormalities, such as cardiac murmurs. This study investigates the feasibility of applying radiofrequency (RF)-confined plasma as a non-invasive analytical platform for high-resolution biochemical assessment relevant to early atherosclerotic changes.

Materials and Methods: RF-confined plasma enables controlled, low-temperature ionization of circulating biomolecules, preserving their molecular integrity while enhancing the detection of oxidized lipids, inflammatory mediators, microvesicles, and metabolic markers implicated in vascular dysfunction.

Results and Discussion: The project also focuses on integrating RF-plasma-based analysis into advanced photonic chip architectures. These architectures are designed to improve optical confinement, boost signal strength, and minimize noise through waveguide and interferometric sensing mechanisms. This combined plasma-photonic system aims to simultaneously capture biochemical signatures related to early atherogenesis and flow-dependent acoustic signals that underlie murmur-related hemodynamic abnormalities. The dual-modality nature of this platform enhances its clinical utility by enabling concurrent biochemical and functional cardiac assessments within a unified, minimally invasive framework.

Conclusion: Preliminary feasibility analysis indicates that the synergy between RF-confined plasma and integrated photonic sensing offers substantial advantages, including reagent-free operation, portability, rapid analysis, system miniaturization, and improved diagnostic precision. Overall, the proposed approach represents a promising pathway toward the development of compact, cost-effective, and non-invasive diagnostic chips capable of supporting early detection, clinical screening, and progression monitoring the progression of atherosclerosis and cardiac murmurs.

Keywords: Argon Plasma Light, Bacterial Inactivation, *E. coli*, Pulsed Light Disinfection, *S. aureus*

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