Multi-modal, configurable optical lab-on- chip platform for low-cost multipurpose diagnostics & monitoring (MultiLab)

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MultiLab project develops a configurable, multi-modal lab-on-chip platform that combines nanophotonic and electrochemical sensing technologies for real-time, multiplexed analysis. The system integrates multiple sensing modalities onto a single chip, enabling precise, low-cost, and scalable diagnostics. It leverages wafer-scale manufacturing data analytics to support point-of-care applications across diverse fields.

MultiLab's objectives include (i) the development of a flexible, low-cost lab-on-chip platform integrating multiple sensing modalities, (ii) the implementation of real-time, multiplexed detection of diverse biological, chemical, and molecular targets, (iii) scalability through compatibility with wafer-scale manufacturing process, (vi) use by non-specialists through automation and intuitive interfaces, and (v) the support of rapid deployment across varied diagnostics and monitoring scenarios. MultiLab integrates core innovations, such as (i) enzyme-based ElectroChemiLuminescence (ECL) sensors for the determination of biomarkers like lactic and uric acids, and environmental indices like dissolved oxygen and H_2S, (ii) Plasmonic Augmented Arrayed Waveguide Grating (PA-AWG) sensor for multichannel, simultaneous sensing of various proteins, miRNA and pathogens, (iii) Photothermal Spectroscopy (PTS) sensors for mid-IR range analysis, using Mach-Zender Interferometers (MZI), (iv) Si_3N_4 Photonic Integrated Circuit (PIC) platform with CMOS compatible plasmonic structures and sensing modules deployed interchangeably based on application needs and (v) Machine Learning (ML) to analyze multiplexed sensor data, implementing advanced techniques. The MultiLab platform will be tested in a healthcare study for diagnosis of fever without an apparent source (FWS) for the differentiation between viral and bacterial inflections, and in an environmental case study for the IoT-based early warning system for Harmful Algal Blooms (HABs).

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