Microfluidics at the Service of Sepsis Diagnostics: the AMBROSIA approach

Introduction

Sepsis remains one of the leading causes of mortality worldwide, demanding rapid and accurate diagnostic solutions. Traditional methods often require hours or even days to deliver results, which can be critical in life-threatening cases. However, conventional molecular diagnostic processes are time-consuming and lack access at urgent care or low-resource areas. Therefore, rapid point-of-care devices have been long desired. In the EU project AMBROSIA, microLIQUID develops a state-of-the-art system, by combining microfluidics with breakthrough integrated plasmo-photonic sensors, enabling fast, precise, and miniaturized sepsis diagnostic lab-on-a-chip platforms.

The Microfluidic Advantage

Microfluidic technologies manipulate small volumes of fluids—often in the nanoliter to microliter range—through networks of microchannels. This approach offers several key benefits for sepsis detection:

- Speed and efficiency: Microfluidics drastically reduces sample preparation and reaction times, due to faster diffusion and mixing rate.
- Minimal sample volume: Small volume of sample is required, making the process less invasive and more patient-friendly.
- Multiplexing: Reaction processes can be multiplexed by combining multiple microchannels
- Precise loading of samples: Microfluidics manipulate the fluids with precise manner with desired volume at the sensor locations
- Integrated workflow and automation: From sample introduction to detection, all steps occur within a single chip with an automated manner, reducing contamination risks and simplifying handling.

Integration with Photonic Sensing

While microfluidics delivers and controls samples and reagents for biochemical reactions (Fig. 1), plasmo-photonic sensors provide the detection mechanism. By integrating optical sensing directly into the chip, the system can monitor biomarkers associated with sepsis—such as procalcitonin or specific cytokines—with high sensitivity. This synergy allows:

- Label-Free Detection: Optical methods often eliminate the need for chemical labels, reducing complexity.
- High Sensitivity: Plasmo-photonic sensors can detect minute changes in refractive index or absorbance, ideal for early-stage sepsis markers.

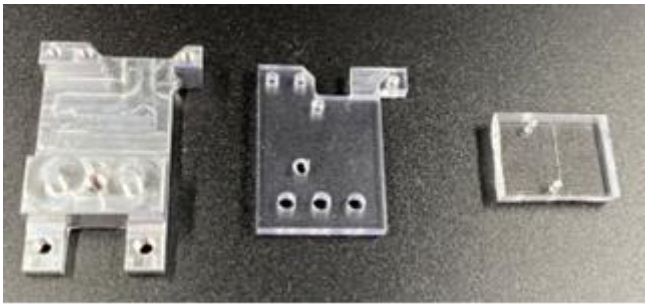

Figure 1. Microfluidic chip design with a single vertical channel and the holder adapted. Sample can be delivered to multiple photonics sensors at once.

Innovation by Integration

The real breakthrough lies in how microfluidics enables multiplexed tests for multiple biomarkers simultaneously on a single chip (Fig. 2). Combined with automated fluid handling and integrated optics, this approach promises:

- Portable Diagnostics: Compact devices suitable for bedside or remote healthcare settings.
- Rapid Decision-Making: Results in minutes rather than hours, critical for initiating timely treatment.
- Scalability: Potential for mass production using polymer-based fabrication techniques.

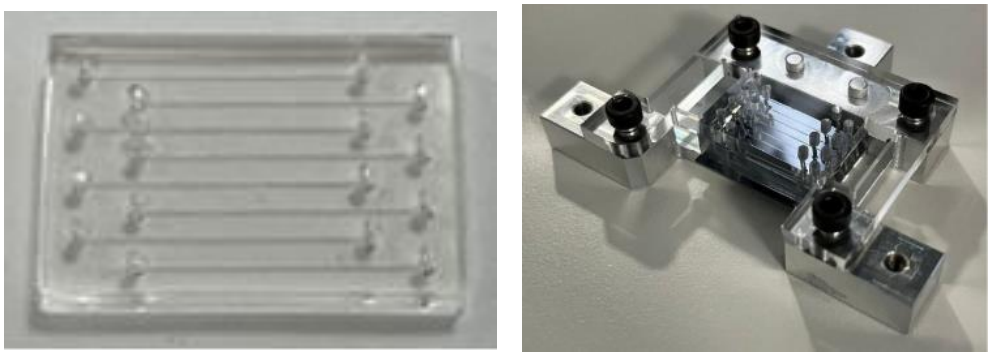

Figure 2. Multiplexed microfluidic chip integrated with photonics sensors. Left: Picture of a PDMS microfluidic chip with 8 independent channels. Right: Picture of a holder that contains the photonic sensor and the PDMS chip.

Looking Ahead

As research advances at AMBROSIA project, microfluidic-photonic integrated platforms are poised to become revolutionizing tools in intensive care units and emergency departments. Their ability to deliver fast, accurate, and cost-effective sepsis diagnostics could save countless lives and reduce healthcare burdens globally.

About AMBROSIA

Duration:

Jan 2023 – Dec 2026 (48 Months)

Coordinator:

Aristotle University of Thessaloniki

Project website:

URL: http://ambrosia-h2022.eu/

Social Media:

LinkedIn

Twitter

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