POSEIDON PROJECT

PHOTONICS AGAINST LEGIONELLA

A new generation sensor to face a significant Health and Safety Societal challenge

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POSEIDON project aims at developing a SPR-based biosensing platform prototype for the detection of *Legionella Pneumophila* bacteria, usable in HVAC systems (Heating, Ventilation and Air Conditioning) by untrained personnel: case study has been developed and proof of concept is under test in an industrially relevant environment setting.

Background

The detection and monitoring of *Legionella* is actually relied on time-consuming protocols (in the order of several days) based on in-vitro selective bacteria culture methods, performed by highly specialized personnel in dedicated laboratories. Detection and investigation of viruses, bacteria and eukaryotic cells is nowadays becoming a rapidly growing field in Surface Plasmon Resonance (SPR) biosensing [Ref 1-2], but the detection was only achieved in laboratory settings. POSEIDON project targets to change the approach in bacteriological environmental monitoring and in infection risk management, improving knowledge towards real applications.

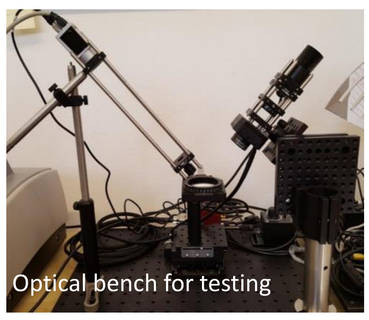

Figure 1

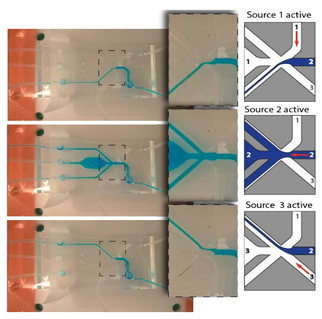

Figure 2

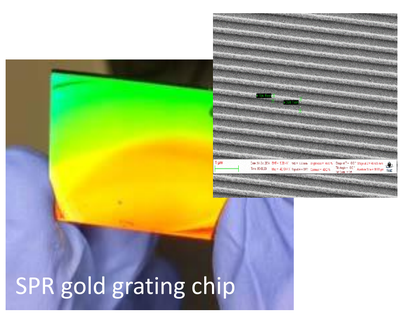

Figure 3

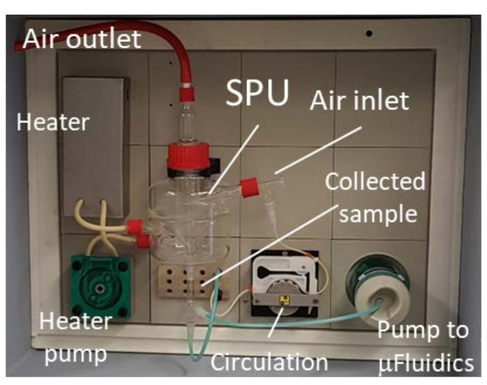

Figure 4

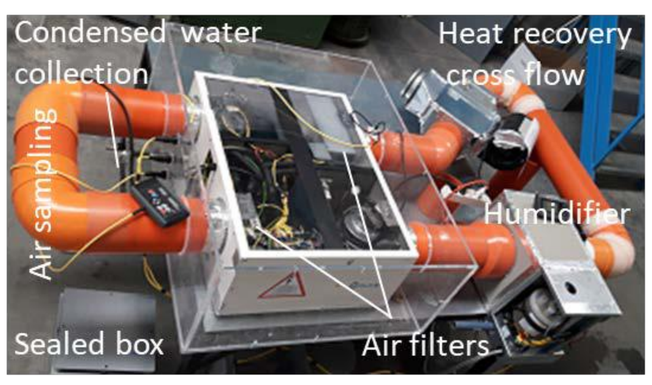

Figure 5

Materials and Methods

The prototype system is composed of several custom components designed and integrated from the handling of the air/water sample in preconditioning unit to the delivery in a microfluidic device through which whole bacteria cells are transported from the sampling module to the sensing plasmonic surface. Microfluidics is composed by a concentrator and a hydrodynamic addressing system for fluidic control (***Fig. 2***). Detection system core is a gold grating (***Fig. 3***) realized by Laser Interference Lithography. Specificity has been ensured by immuno-based functionalization of grating surfaces and system sensitivity has been granted by the optimization of the optical detection system architecture (***Fig. 1***).

Results

Sampling and Preconditioning Unit (SPU) has been designed, realized and tested (***Fig. 4***). Procedure of sampling and preconditioning of water samples has been proved with real blind environmental samples and has been validated comparing with culture results (gold standard method ISO 11731). For air samples, it has been tested with reference to a commercial microbiological impactor. Furthermore, a cleaning procedure was defined and tested out to eliminate lime adhesion and to avoid cross-contamination in subsequent sampling. A microfluidic system aiming to concentrate, capture and incubate the sample has been developed: it acts as a bridging unit in the instrument from the SPU to the SPR sensor. Grating Coupled Surface Plasmon Resonance (GC-SPR) in azimuthally rotating configuration have been applied for detection of pathogens. The integrated sensing system is currently under test. HVAC system has been implemented in a custom aeraulic circuit (***Fig. 5***) to allow testing the Legionella monitoring in controlled environment and for the validation of the whole detection system.

Conclusions

An innovative sensing device architecture is under test to yield reliable measurement readouts of pathogenic presence. The prototype implements water and air sampling, sequential concentration, injection into microfluidic system and delivery to the SPR sensor for analysis. The system is designed for its future integration in HVAC plants for prevention of *L. Pneumophila* outbreaks.

References

1. Homola et a., Chem. Rev. 108, **462–493** (2008).
2. Abadian et al., Anal Chem. 18; **86** (6):2799-812 (2014).

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PHOTONICS PUBLIC PRIVATE PARTNERSHIP

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