Simultaneous detection of Salmonella typhimurium and Escherichia coli O157:H7 in drinking water with Mach-Zehnder interferometers monolithically integrated on silicon chips

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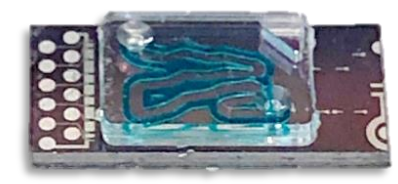
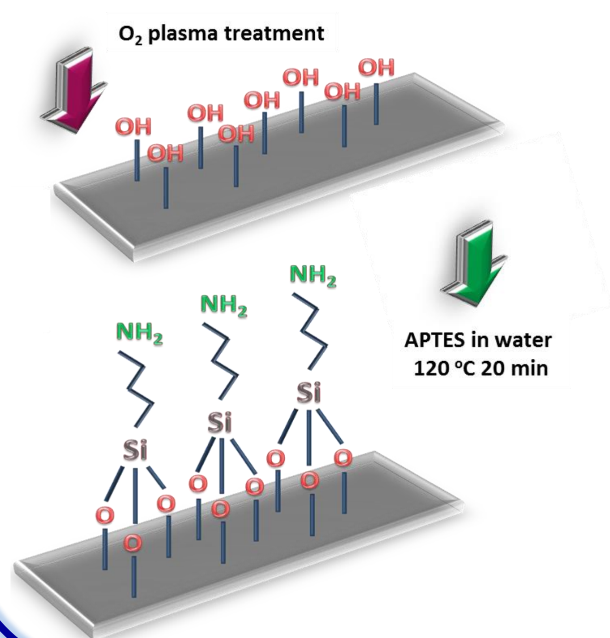


Introduction

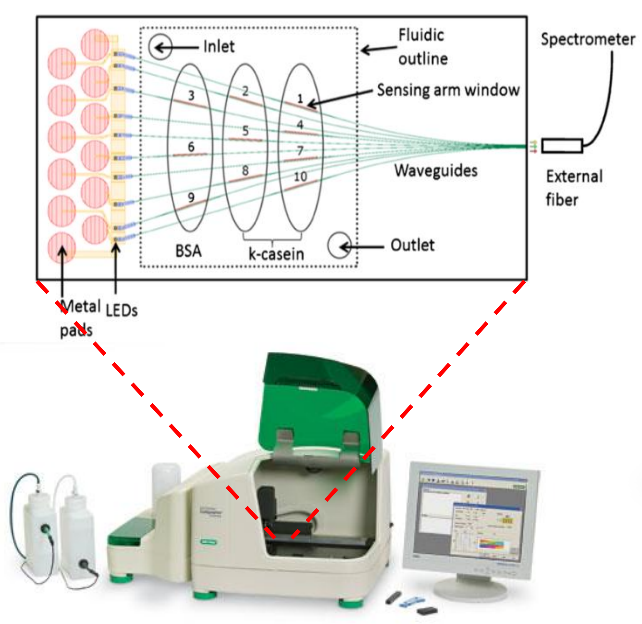
Bacteria detection in food is very important, since in the US approximately 9 million cases/year are related to foodborne illness caused by 31 pathogenic bacteria among which Salmonella spp. and Escherichia coli O157:H7 [1]. Therefore, rapid, sensitive and accurate methods for bacteria detection are crucial for consumer’s health and food industries. The conventional methods for identification of bacteria are based on culturing and plating. However, they require several days for the completion of the analysis. To shorten the analysis time ELISA- and DNA-based methods have been employed for bacteria identification but they are not appropriate for point of need applications [2, 3]. For this reason, recently, biosensors are gaining ground in foodborne bacteria detection. Here, we present a miniaturized immunosensor for the simultaneous, label-free, real-time determination of bacteria in milk.

Methods

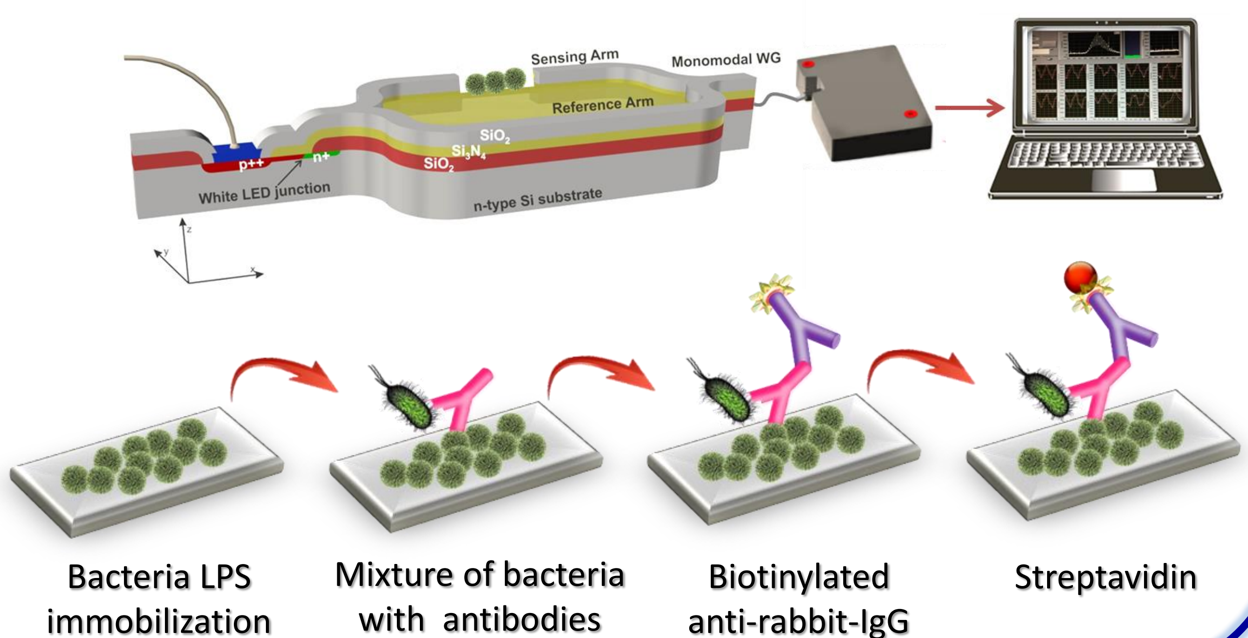
Chemical activation of MZI chip



Biological activation of MZI chip

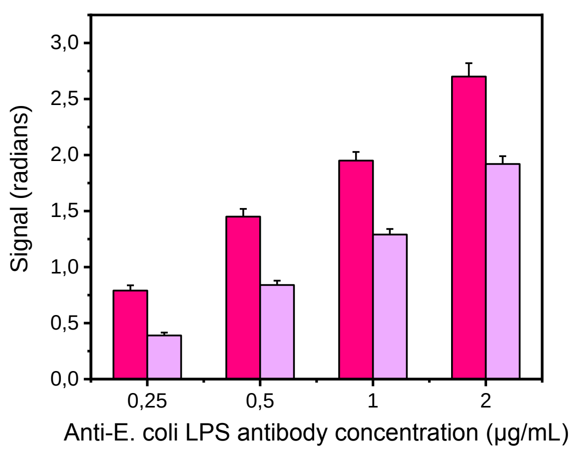


3D schematic of an integrated MZI modified with bacteria LPS



Results

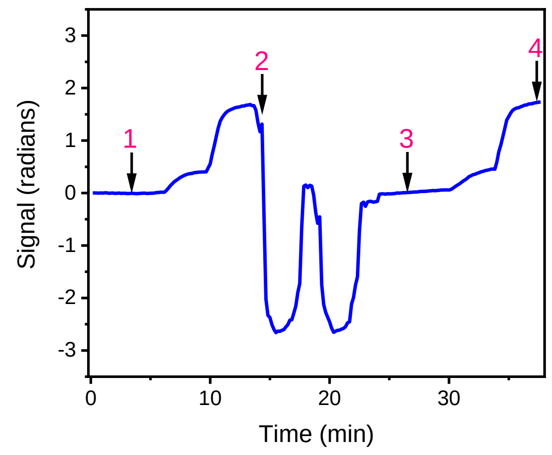
Optimization of antibody concentration



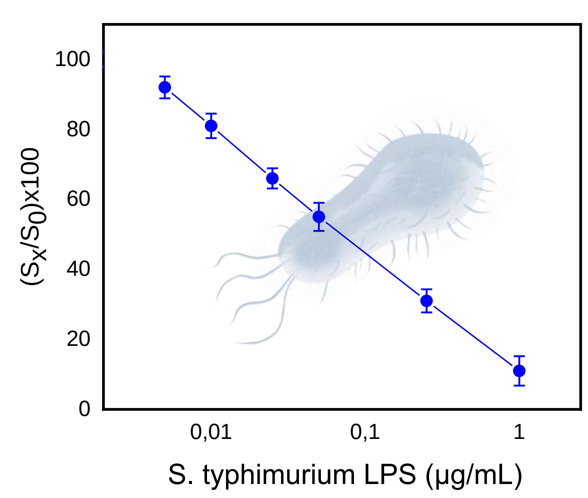
Adequate signal and high sensitivity were achieved by using *E. coli and S. typhimurium* LPS antibody at concentrations of 0.5 and 1 μg/mL, respectively.

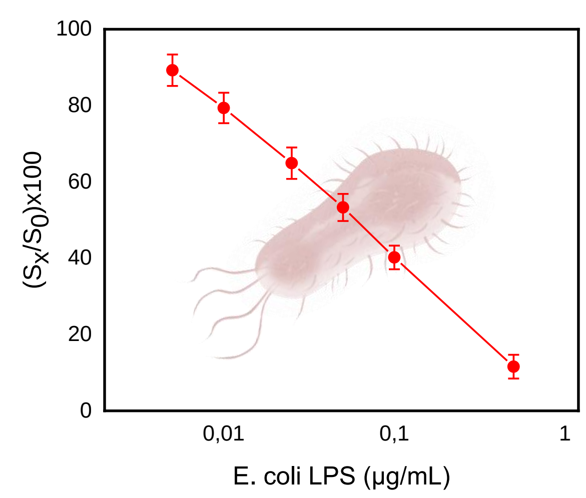
Matrix effect

As shown, the real-time response obtained for S. typhimurium zero calibrator prepared in assay buffer (arrow 1 to 2) was almost identical with that obtained from zero calibrator in tap water (arrow 3 to 4).



Calibration curves of S. typhimurium and E. coli LPS





Analytical characteristics of the method

LPS	*S. typhimurium*	*E. coli*
Limit of detection (LOD)	**4 ng/mL**	**4 ng/mL**
Dynamic range (D.R.)	4 – 1000 ng/mL	4 – 1000 ng/mL
Inter-assay CV	< 4%	< 5%
Intra-assay CV	<7%	<7%

Conclusions

In this work, a miniaturized MZI immunosensor for the simultaneous determination of S. *typhimurium* and E. *coli* in drinking water was developed. The assay was accurate, repeatable and sensitive with detection limits at the order of 10^2 cfu/mL. Thus, it is expected that the proposed sensor could find wide application in Drinking Water Distribution System and in low resources environment for the fast on-site monitoring of bacteria.

References

[1] E. Scallan et al., *Emerg. Infect. Dis.* **2011**, *17*, 7–15.
[2] D.I.Walker et al., *Water Res.* **2017**, *126*, 101–110.
[3] W. Wang et al., *Sensors* **2015**, *15*, 5281–5292.

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