Towards a catheter based sensor for the electronic detection of histamine in the intestinal tract

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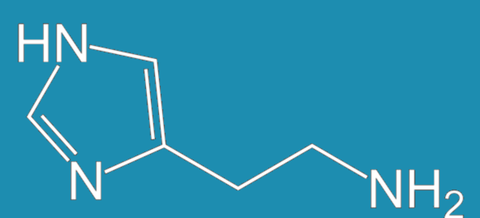


Introduction

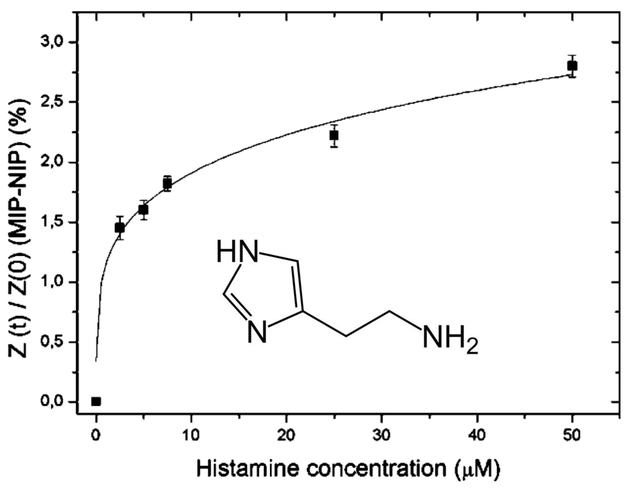
Irritable bowel syndrome (IBS) is a disease affecting up to 15% of the population in the developed world. Symptoms such as abdominal pain, diarrhea, constipation and psychological problems negatively affect the patient's life leading to an economical burden on society due to an increased absence from work and costs related to medical care. Literature suggests that an elevated histamine concentration in the gastrointestinal (GI) tract due to overactive mast cells can be both an indicator and cause of IBS [1].

The current detection method requires extraction of gastro-intestinal fluids by endoscopy of the GI tract. The histamine concentration is then measured by expensive techniques such as high pressure liquid chromatography (HPLC). On the other hand, molecularly imprinted polymers (MIPs) offer a low-cost alternative to HPLC. Recently these MIPs have been used in combination with electrochemical impedance spectroscopy and the heat-transfer method (HTM) to detect histamine, serotonin and nicotine in body fluids [2-3].

Figure 1. Mast cells release histamine into the GI tract upon activation.

Experimental

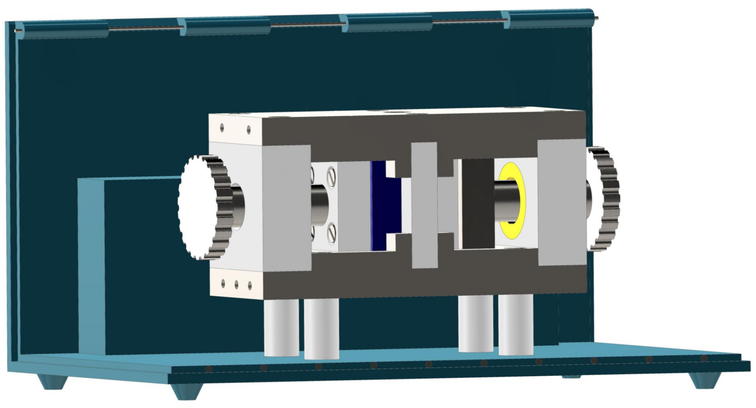
Figure 2. impedimetric measurement of a histamine MIP sensor from our existing measurement setup. A rise in impedance can be observed when increasing con-centrations of histamine are sequentially added to the sensor.



Previous experiments have proven that it is possible to use impedimetric MIP based sensors in order to detect histamine in bowel fluids down to a micromolar range [4].

The modification and integration of our sensors into a medical device allows us to create low cost sensors to benefit both patients and doctors.

Figure 3. Schematic representation of the external measurement device.



First, we are working towards an external flow-through cell for refer-ence measurements outside the body. This external measurement device can be fed with GI tract fluid in order to detect various substances of interest with an array of planar electrode spots sensitized with MIPs.

Both the catheter based sensor and the external measurement device allow us to experiment with various functionalization methods such as dip-coating and surface grown MIP layers.

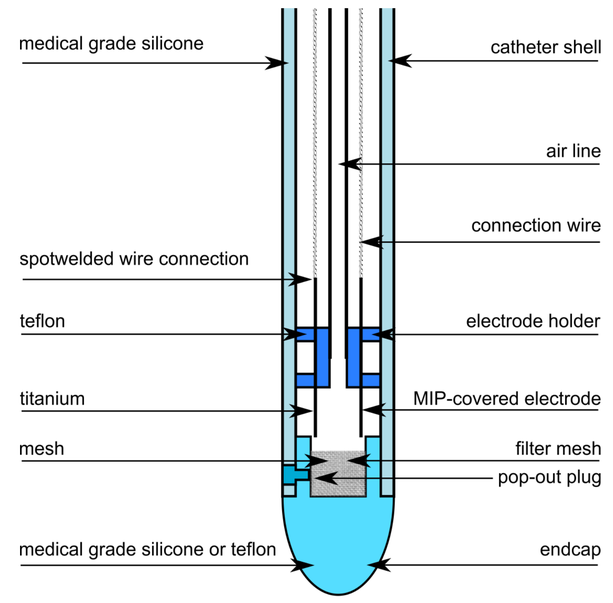


Figure 4. Scheme of the sensor catheter.

In parallel, we work on the inte-gration of a MIP based sensor into a gastrointestinal catheter. Impedance spectroscopy is the read-out method of choice since this is already established in the medical context. The catheter will be made of medical grade silicone with an endcap to protect the sensor from the acidic environment of the stomach. Suction is then applied to the catheter in order to bring GI fluid in contact with the wire-shaped sensor electrodes.

Conclusion

These first steps towards the clinical application of MIP based biosensors have the potential to improve existing measurements on patients suffering from IBS and decrease the time it takes to acquire patient data. Our approach with two separate devices and multiple functionalization routes promises a high flexibility regarding assay formats and diagnostic applications .

References

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[3] M. Peeters *et al.* Heat-transfer-based detection of L-nicotine, histamine, and serotonin using molecularly imprinted polymers as biomimetic receptors, Anal Bioanal Chem, 2013, 405(20), 6453-6460

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Acknowledgements

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