Printed Polyaniline-Modified Interdigitated Electrodes For Detection And Quantification Of Ammonia In Breath

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INTRODUCTION

- A range of pathological conditions can lead to elevated blood ammonia and urea nitrogen levels
- These include kidney and liver dysfunction and urea cycle defects
- These conditions result in severe reduction in quality and quantity of life
- Blood nitrogen levels are controlled by dialysis and monitored using invasive blood tests
- Blood nitrogen levels have the potential to be monitored non-invasively in by measuring ammonia in breath [1]
- We have developed a device for monitoring human breath ammonia levels (Fig. 1)

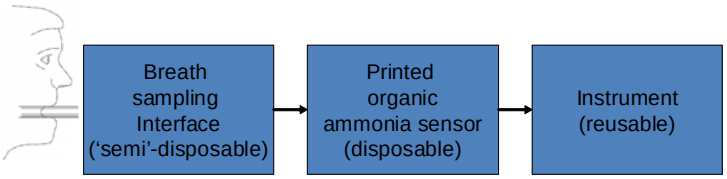

Figure 1. The AmBeR system for monitoring breath ammonia concentrations.

DESCRIPTION OF THE SYSTEM

- The AmBeR **Am**monia **Br**e**a**th Monito**R** (Fig. 1) is a system that has three main components:

1. A semi-disposable breath sampling user interface
2. A disposable printed organic sensor for detection of ammonia
3. Readout instrumentation

THE PRINTED AMMONIA SENSOR

- The printed sensor is based on advanced nanomaterials and print fabrication technology (Fig. 2)
- Interdigitated electrodes are fabricated from screen-printed silver inks [2]
- The ammonia sensing layer is fabricated via the deposition of inkjet printed polyaniline nanoparticles [3]
- This combination makes the electrodes mass producible and highly reproducible with excellent sensitivity to ammonia down to low ppb levels
- Background ammonia levels in breath can be as low as a few ppb

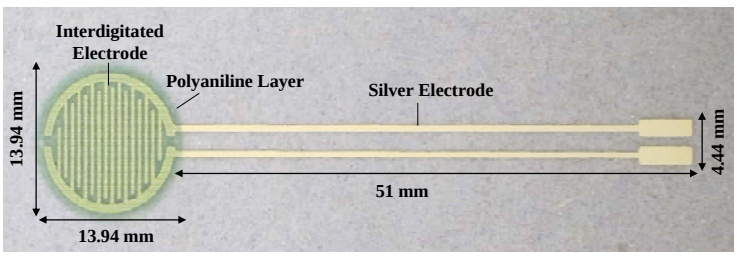

Figure 2. A printed ammonia electrode.

PRINCIPLE OF OPERATION

- Exposure of the polyaniline to ammonia results in the de-doping of the semi-conducting emeraldine salt to the insulating emeraldine base (Fig. 3)
- The change in conductivity can be measured using a range of electrochemical techniques
- Measurement in breath must deal with interference from temperature and humidity effects

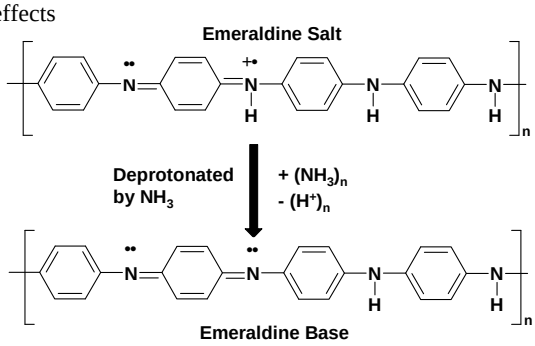

Figure 3. Schematic of protonated and deprotonated forms of polyaniline.

SYSTEM PERFORMANCE

- The human breath ammonia monitor is capable of detecting ammonia between 40 and 2,993 ppbv in simulated breath (Fig. 4)
- This covers the clinically important range necessary to monitor patients during haemodialysis
- Breath humidity and temperature do not result in significant interference

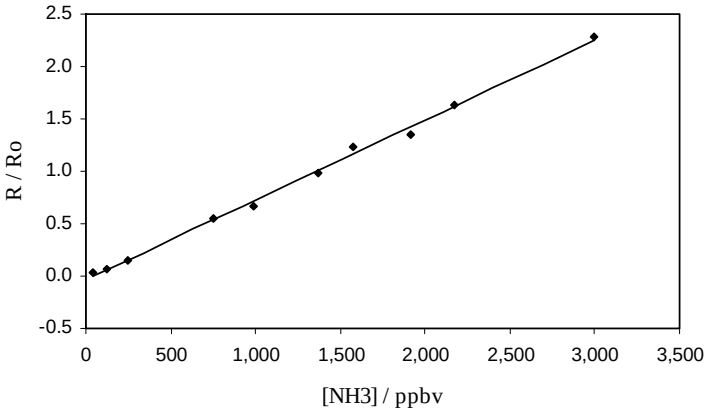

Figure 4. Calibration of ten simulated breath ammonia concentrations using the nanoPANI-IDE. A correlation of 0.9965 (n=3) was generated between the ammonia concentrations and the change in resistance.

CONCLUSION

- Preliminary results show that this device has potential for detecting ammonia at background levels in human breath
- It is believed that the device will prove useful as a diagnostic device for assisting with haemodialysis, diagnosis of *Helicobacter pylori*, identification of halitosis, analysis of hepatic encephalopathy, evaluation of asthma, and other disorders associated with elevated breath ammonia levels

REFERENCES

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