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Steps towards higher throughput screening methods: Infrared spectroscopy studies of ion-selective electrode membranes

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Master thesis, Molecular Technologies

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INTRODUCTION

Sensors are important devices that give critical information about the surrounding environment (Cammann *et al*., 2013). Ion Selective Electrodes (ISE) are an example of a potentiometric sensor used in environmental and clinical analyses (Fig 1). The ISE membrane can consist of as many as a 1000 different combinations to form a functioning device (Fig 1 membrane). Also there are many different interactions and interferences from samples such as blood.

Traditionally ISE development is performed on completed electrodes and new approaches are needed to be able to identify the critical components efficiently such as used in combinatorial chemistry (high throughput screening - HTS). Such approaches require simple and fast sample preparation and characterization. The objective of this work is the initial step to establish methods to characterize chloride ISE membranes. With rapid membrane analysis, this is a step towards HTS.

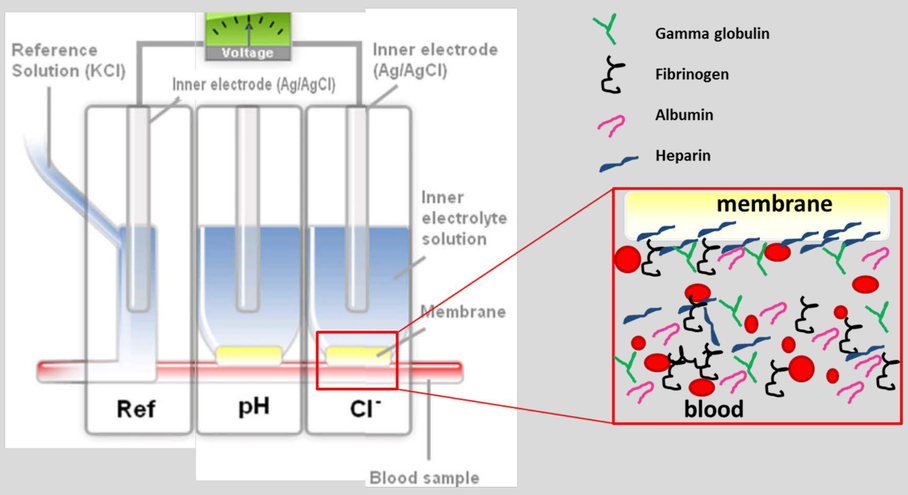

Fig. 1: The figure shows a schematic representation of an ion-selective electrode (ISE). On the right side are blood proteins and heparin schematic depicted, which interact with the membrane during the measurement.

METHODS

The ISE membranes under investigation were a combination of TDMAC as an ion exchanger & PVC as the polymer matrix (Fig 2) casted on microscope slides. The membranes were exposed to different blood based samples under dynamic conditions (rotation). Their interactions with the membrane are analyzed by IR, Raman & radioactive labelling as potential HTS characterization methods

*Fig. 2: **A** is the chemical structure of tridodecylmethylammonium-chloride (TDMAC) and **B** is the chemical structure of poly (vinylchloride) (PVC).*

RESULTS & DISCUSSION

Characterization of the membrane

ATR-FTIR and Raman were used to characterize the membrane composition. FTIR was best suited for studies involving the ion exchanger and Raman for the polymer matrix (Fig 3).

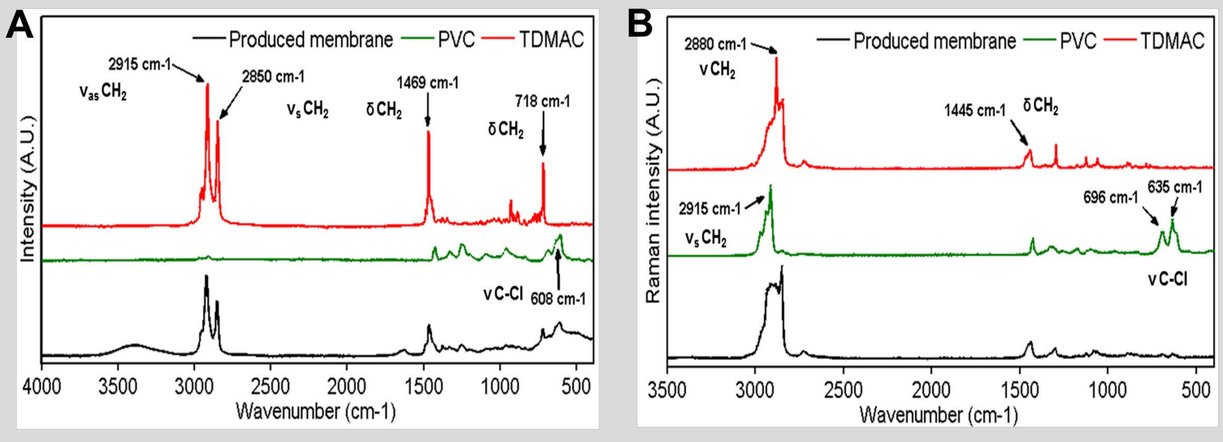

*Fig. 3: **A** is an ATR-FTIR spectra of tridodecylmethylammonium-chloride (TDMAC) and poly (vinylchloride) (PVC) and the produced membrane, with characteristic peaks labelled. **B** is a Raman spectra of TDMAC, PVC and the produced membrane.*

Adsorption experiments

Adsorption studies were performed with blood, plasma and serum. Adsorption products were observed with blood and plasma, but not with serum (fig 4).

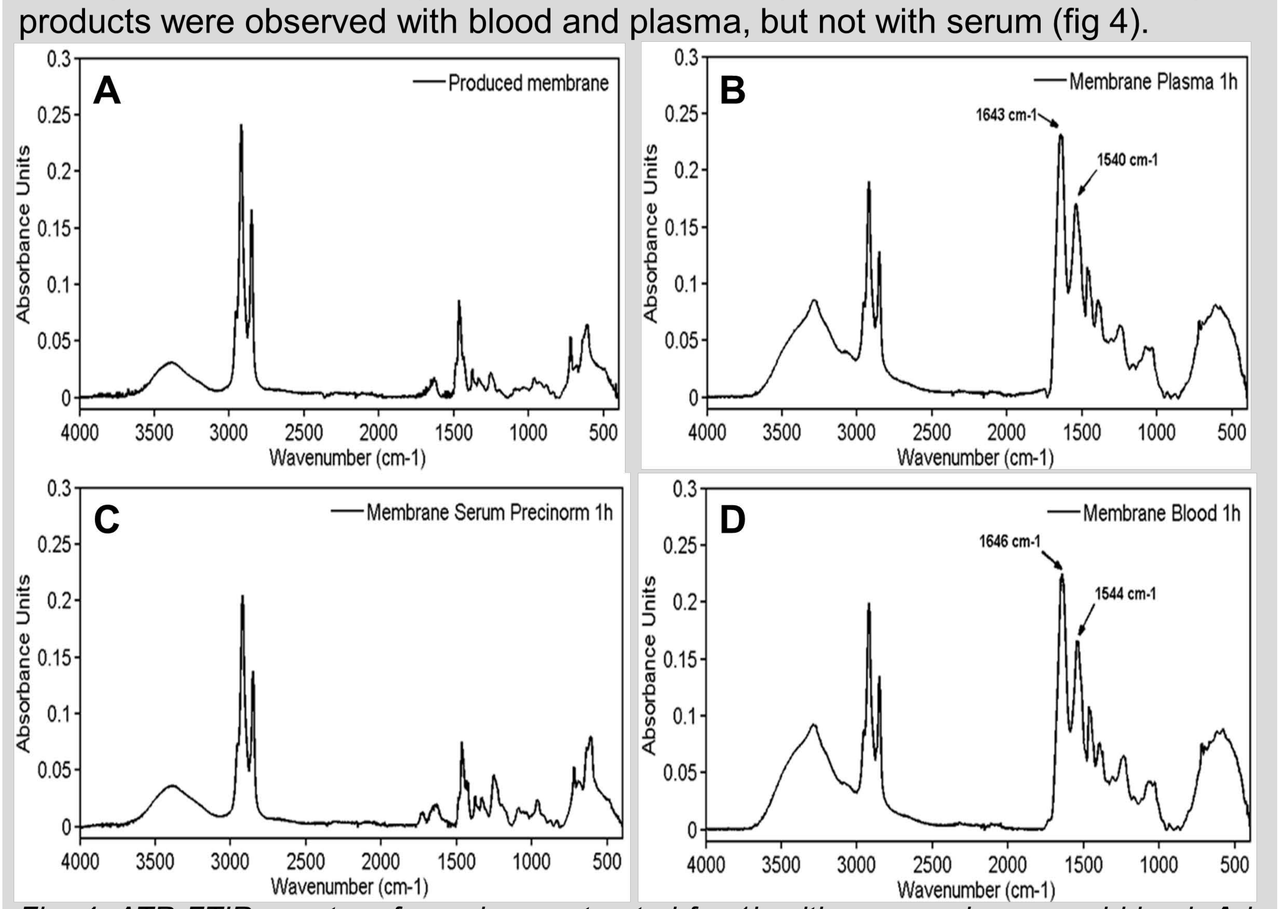

*Fig. 4: ATR-FTIR spectra of membranes treated for 1h with serum, plasma and blood. **A** is the spectrum of the produced membrane. **B** shows compounds adsorbing from plasma to the surface. The peaks at 1643 cm^{-1} and 1540 cm^{-1} are characteristic for protein adsorption. **C** depicts that no compounds are adsorbing from serum to the membrane. **D** is the spectrum of a blood treated membrane, revealing the protein adsorption.*

From the analysis of the 3 major components of blood based samples and the anticoagulant (heparin), only BSA did not adsorb. Based on the scanning electron microscope (SEM), ATR-FTIR and the radioactive measurement heparin adsorbs strongly to the membrane and has distinctive spectral characteristics features (Fig.5).

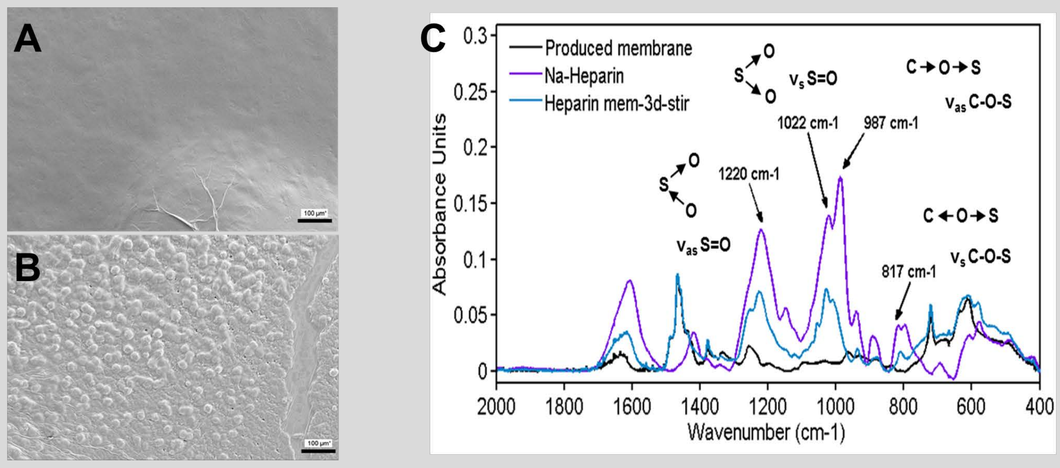

*Fig. 5: **A** is a SEM image of a produced membrane before the treatment (300x), and **B** after treated with heparin for 4h, stirring at 200 rpm (300x). **C** represents heparin ATR-FTIR spectra compared to the adsorbed heparin in the membrane and a produced membrane.*

CONCLUSION

In this work the adsorption of blood proteins as well as heparin to the surface of the chloride ISE membrane was investigated using ATR-FTIR. Reproducible and rapid methods were developed for the preparation and characterization of the chloride ISE membrane. These methods are potentially suitable to characterize such interactions in a HTS.

REFERENCE

[1] Cammann K., Ross B., Katerkamp A., Reinbold J. et al. (2013): Chemical and Biochemical Sensors, Ullmann's Ecyclopedia of Industrial Chemistry, Weinheim: Wiley-VCH Verlag, 8, 109-221.

ACKNOWLEDGEMENT

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