

Electrochemical biosensor for the quantification of Urea in dialysate and blood

L. Sembranti

F. Vivaldi, F. Di Francesco

Department of chemistry and industrial chemistry, University of Pisa, Via Giuseppe Moruzzi 13, 56124, Pisa, Italy

Lorenzo.sembranti@unipi.it

Since the invention of dialysis, patients with renal diseases have benefited from a noticeable increase in both quality of life and life expectancy due to the continuous progress of this therapy. In 1985, a group of researchers led by Gotch and Sargent introduced a parameter with the objective of assessing the adequacy of dialysis: Kt/V [1]. During this therapy, the concentration of uremic toxins in blood decreases exponentially. Kt/V is correlated with the concentration of urea in plasma pre- and post-dialysis and represents the exponential coefficient related to urea clearance. The efficiency of filtration also varies with molecular size, and urea is considered the ideal marker for assessing the removal of small molecules. For these reasons monitoring urea concentration in dialysate ensures effective hemodialysis and helps healthcare providers adjust treatment for optimal results. In this work, an enzymatic electrochemical biosensor for the detection of urea is proposed. The system, which requires minimal sample pretreatment, makes use of urease, a NAD/FAD independent enzyme, and a pH sensitive indoaniline derivative, can be used to perform live measurements in both dialysate or blood during treatment. The sensing mechanism is relatively simple. The ammonia, produced from the breakdown of urea by urease, originates a local variation of pH that is first measured by assessing the shift of the indoaniline derivative peak in square wave voltammetry (figure A), and then correlated to the urea concentration. Sensors with different dynamic ranges can be fabricated by varying the amount of enzyme during production (figure B), allowing sensor use in matrices with different concentration levels of the target analyte.

References

- [1] F. A. Gotch and J. A. Sargent, "A mechanistic analysis of the national cooperative dialysis study (NCDS)," *Kidney Int.*, vol. 28, no. 3, pp. 526–534, Sep. 1985.

Figures

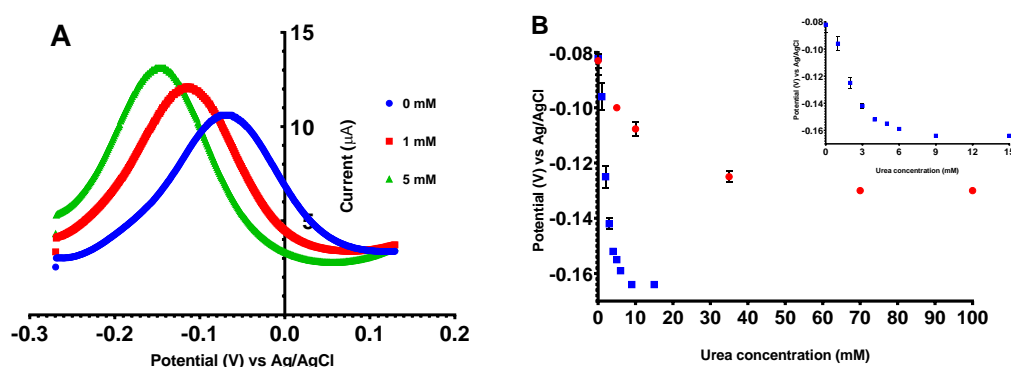


Figure 1: (A) Square wave voltammeteries in PBS at varying concentrations of Urea. (B) Calibration curves of two sensor fabricated using different amount of enzyme