Transparent and flexible $Ti_3C_2T_x$ MXene electrochemical sensors for H_2O_2

Natalia Noriega
Marcus K. Dymond[1], Joseph Lacey[3], Susan Sandeman[1], Yury Gogotsi[2], and Bhavik Anil Patel[1]
[1] *School of Applied Sciences, University of Brighton, Brighton, UK*
[2] *A.J. Drexel Nanomaterial Institute, Drexel University, Philadelphia, USA*
[3] *Rayner Intraocular Lenses Limited, The Ridley Innovation Centre, Worthing, UK*
M.NoriegaPedraza@brighton.ac.uk

MXenes are a family of 2D transition metal carbides and nitrides with unique properties that make them attractive for a wide range of applications [1]. Among these, $Ti_3C_2T_x$ is notable for its high conductivity and has been shown to improve the sensitivity towards several analytes, including dopamine, glucose and urea when combined with other electroactive materials within a sensor [2]. In this study, we developed transparent and flexible pristine $Ti_3C_2T_x$ electrodes for the detection of H_2O_2. Electrode optimisation was initially performed using vacuum-filtered films to allow for precise control of electrode parameters. Probe sonication (20 min, amplitude of 50%, 8:2 sec ON:OFF) was performed in as-synthesized MXene to reduce the size of flakes and study their impact on electrode performance. Thickness was also varied (4 and 8 µm) by increasing the amount of MXene filtered. Thin $Ti_3C_2T_x$ films were deposited onto hydrogels via spray-coating to assess their performance as transparent electrodes and investigate their electrochemical activity during mechanical bending. UV-vis spectroscopy was used to determine light transmittance of different deposition times of $Ti_3C_2T_x$ colloidal solution. Amperometric responses (-650 mV vs Ag | AgCl) to 1 mM H_2O_2 in 0.1 M PBS were recorded as the assessment of this electrochemical study. Results indicate that the sensitivity towards H_2O_2 is independent of electrode thickness (Figure 1a). Additionally, reducing the flake size from >1000 µm to 260 nm significantly increased the signal response to H_2O_2 (Figure 1b). The optimized $Ti_3C_2T_x$ electrode exhibited a linear response towards H_2O_2 concentrations in the range of 20 µM to 500 µM with good electrode stability, reproducibility and selectivity. Successful determination of H_2O_2 concentrations using flexible and transparent $Ti_3C_2T_x$-coated hydrogels demonstrates the application of the unique combination of MXene properties in electrochemical sensing. Overall, our findings demonstrate the potential of pristine $Ti_3C_2T_x$ for the development of electrochemical sensors for the detection of H_2O_2, which has important implications for various fields, including biosensing, environmental monitoring, and clinical diagnostics.

References

[1] X. Li et al., Nat. Rev. Chem., 6 (2022) 389–404
[2] K. Kalambate et al., Trends Anal. Chem., 120 (2019) 115643

Figures

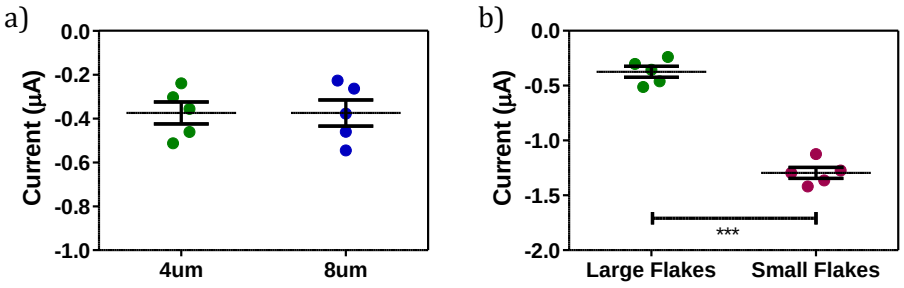

Figure 1: Impact of pristine $Ti_3C_2T_x$ electrode a) thickness and b) flake size on amperometric response to 1 mM of H_2O_2 in 0.1 M phosphate buffer saline (PBS) at -650 mV vs Ag | AgCl