The investigation of chlorpyrifos (Cpy) detection of PEDOT:PSS-MXene(Ti2CTX)-BSA-GO composite using P-ISFET reduction method

ABSTRACT

MXenes are two-dimensional materials that are attractive for applications as sensors because they possess high conductivity, super hydrophilicity and high surface area. There already exist substantial researches on the use of $Ti_3C_2T_x$ based MXenes as electrochemical biosensors, but in contrast Ti_2CT_X based MXenes are rarely discussed due to their inherent resistance instability. However, the use of Ti_2CT_X based MXenes is still worth exploring as theoretical studies have shown that Ti_2CT_X possesses a significantly lower bandgap compared to many other MXenes structures. Herein, this study examines the use of Ti_2CT_X MXene structures in a P-channel ion-sensitive field-effect transistor (P-ISFET) for the detection of Chlorpyrifos (Cpy). Compositing the PEDOT:PSS thin film with delaminated Ti_2CT_X MXenes flakes with graphene oxide (GO) and bovine serum albumin (BSA) allows it to maintain its sheet resistance at around 100 kOhm for 3 days. Interestingly when using the composite thin film, the minimum threshold voltage required to observe Cpy electroreduction is −0.1 V. This is much lower than that when using titanium dioxide (TiO_2), which is −1.5 V. Composite thin films containing Ti_2CT_X MXene are found to detect Cpy with higher sensitivity compared to thin films without MXene. This is because the presence of Mxene in the PEDOT:PSS composite thin films improves the surface area available for Cpy detection. This study highlights the potential of Ti_2CT_x MXene-BSA composite as a promising 2D material for enzyme-free CPY detection.