Selective Electrochemical Detection of Doxorubicin Using Molecularly Imprinted Polymer-Modified Boron Doped Diamond Electrodes

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Drug detection in biological solutions is crucial for tracking pharmacokinetics in the body. Electrochemical detection methods are promising for accuracy and rapidity, but measuring multiple drugs that react at similar potentials is difficult. Therefore, molecularly imprinted polymers (MIPs) were modified onto the electrode surfaces. The MIP has specific cavities whose shape fits template molecules and enables selective detection. Boron doped diamond (BDD), known for its high functions, was chosen as an electrode material [1]. In this study, doxorubicin (DOX), an anticancer drug, was used as the template molecule, and an electrochemical sensor that can detect DOX specifically and with high sensitivity was developed. In electrochemical measurements of DOX using an unmodified BDD electrode, a maximum reduction current from the background current was observed at -0.52 V *vs.* Ag/AgCl [2] (Signal-to-background ratio (S/B) = 123 (300 nM)). Other drugs, an antiepileptic drug, clonazepam (CZP), for instance, exhibited a reduction reaction (S/B = 35.2 at -0.67 V *vs.* Ag/AgCl)) when a similar potential was applied (Figure 1(a)). When their mixed solution was measured using the unmodified BDD electrodes, it would be difficult to only measure the concentration of DOX. In a similar measurement using the MIP-BDD electrodes, DOX reduction current increase was observed (S/B = 8.14 (300 nM at -0.56 V *vs.* Ag/AgCl)), but CZP reduction current increase decreased (S/B = 4.35 (300 nM at -0.75 V *vs.* Ag/AgCl)) (Figure 1(b)). This suggests that the MIPs using DOX as template molecules inhibited the reduction of CZP and enabled selective DOX measurements. The DOX in plasma was measurable using the electrochemical DOX-sensor based on the MIP-BDD electrodes. It exhibited the DOX concentration-dependent current increase in plasma. This MIP-BDD sensor may be helpful for therapeutic drug monitoring (TDM) in human patients.

References

[1] Y. Einaga, J. Appl. Electrochem., 40 (2010) 1807 – 1816.
[2] H. Moriyama et al., Analyst, 147 (2022) 4442 – 4449.

Figures

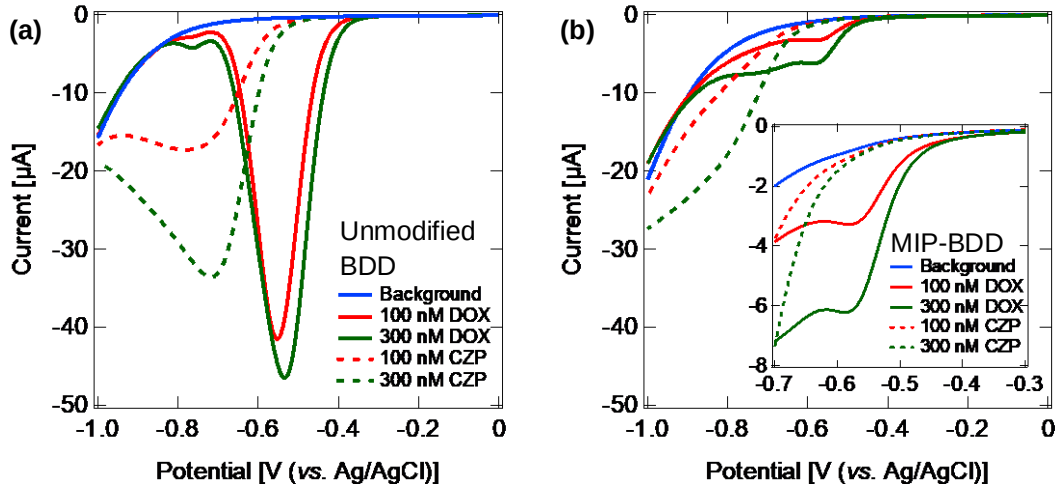

Figure 1: Linear Sweep voltammograms of DOX and CZP in PBS using (a) an unmodified BDD electrode and (b) an MIP-BDD electrode.