タウリン検出用分子インプリンティングポリドーパミンを修飾した延長ゲート型有機トランジスタ

Extended-Gate Type Organic Transistor Functionalized with Molecularly Imprinted Polydopamine for Taurine Detection

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Molecularly imprinted polymers (MIPs) are known as the fascinating technology for the highly-sensitive and selective detection of target molecules, which stems from specific cavities in the polymers. However, complicated and expensive analytical devices are necessary for reading out the response of MIPs, which would limit the application of MIPs. For exploring low-cost and easy-to-use applications of MIPs, herein we have developed a MIP-attached organic field-effect transistor (MIP-OFET)[1)]. The OFET possesses an extended gate electrode covered with an electrochemically polymerized dopamine for the detection of taurine (Tau). Tau plays important biological roles in cardiovascular function and central nervous system depression, and exists widely in daily drinks. The concept of the MIP-OFET is shown in Figure 1(A). By controlling applied voltage on the gate electrode, the semiconductor layer made of PBTTT forms a carrier channel between source and drain electrodes, and then drain current is amplified. The capture of Tau by the MIP has effects on the surface potential on the extended-gate, leading to the change in threshold voltage (V_{TH}) of the OFET. First, we optimized and evaluated the conformation and noncovalent interactions of the molecular cluster among dopamine, 1,2-phenylenediamine, and Tau by the DFT calculation (Figure 1(B)). Four monomers surrounded and firmly captured Tau by hydrogen bonds. Next, we applied cyclic voltammetry for the electrochemical polymerization (Figure 1(C)), followed by the extraction of the template. Differential pulse voltammetry (DPV) was utilized to evaluate the recombination of Tau and the MIP (Figure 1(D)). The decrease of the current peak depending on the concentration of Tau suggested that the recombination of Tau and the MIP prevented $FeCN_6^{3-}$ penetrating the MIP. Finally, we investigated the sensing ability of the MIP-OFET (Figure 1(E)). As a result, the V_{TH} shift in transfer characteristics showed linear response to Tau (0-20 μM), detecting Tau with high sensitivity in comparison to the other electrochemical methods (*e.g.*, DPV).

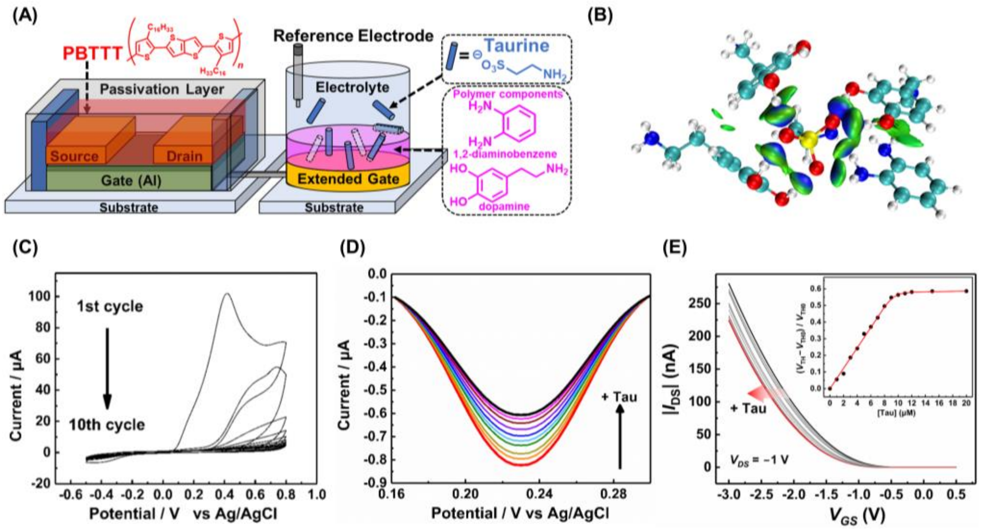

Figure 1. (A) Schematic illustration of the MIP-covered extend-gate type OFET. (B) The isosurface Independent Gradient Model figure of the DFT optimized complex with dopamine, 1,2-diaminobenzene, and Tau. The molar ratio equals to 3:1:1. The green and blue areas indicate the weak and strong noncovalent interactions, respectively. (C) Cyclic voltammograms obtained during the formation of a MIP film on the surface of the Au electrode. (D) The DPV of the MIP-covered electrode with various concentrations of Tau in a phosphate buffer (10 mM) including K_3FeCN_6 (10 mM), KCl (100 mM) at pH 7.0. (E) Transfer characteristics of the MIP-OFET upon the addition of Tau in a PBS (10 mM) with KCl (50 mM) at pH 7.4. Inset: Titration isotherm corresponding to the Tau-induced V_{TH} shift. [Tau] = 0–20 μM.

1) Q. Zhou, M. Wang, S. Yagi, T. Minami, *Nanoscale*, **13**, 100 (2021) (**Invited paper, Inside front cover**)