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RESEARCH PAPER

Electrochemical Dopamine Biosensor Composed of Silver Encapsulated MoS_2 Hybrid Nanoparticle

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Abstract Dopamine is an important neurotransmitter in central nervous system as an indicator of several neurological disorders such as Parkinson's disease. The accurate monitoring of dopamine level is the significant factor for prevention and diagnosis of various neurological disorders. Commonly used metal nanoparticles such as gold and platinum for electrochemical dopamine detection have limitations such as low sensitivity and low linearity at low concentration of dopamine. In this study, for the first time, silver encapsulated MoS_2 (Ag/MoS_2) hybrid nanoparticle was developed and spin-coated on the indium tin oxide (ITO) electrode to enhance the electrochemical signal for dopamine detection. This newly developed biosensor induced the well-orientation of Ag/MoS_2 hybrid nanoparticle, high reproducibility and high sensitivity at low dopamine concentrations compared to the previously reported biosensors. Thus, our newly fabricated electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle can be applied to monitor the level of dopamine accurately for diagnosis and prevention of various neurological disorders with the electrochemical signal enhancement.

Keywords: Ag nanoparticle, MoS_2, Ag/MoS_2 hybrid nanoparticle, dopamine, electrochemical signal

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1. Introduction

Dopamine is an essential neurotransmitter that plays an important role in central nervous system [1-4]. The presence of abnormal level of dopamine is a sign of neurological diseases such as Schizophrenia, attention deficit hyperactivity disorder (ADHD) and Parkinson's disease [5,6]. For this reason, accurate detection and quantification of dopamine is important for monitoring, diagnosis and prevention of various neurological diseases. To monitor the level of dopamine, various methods have been developed in the past, such as immunoassay [7], high performance liquid chromatography (HPLC) [8,9], spectrophotometric [10] and coulometric method [11]. Among these various methods, the electrochemical detection method has been widely studied recently due to its simplicity, high sensitivity and fast response time without complex preparation steps, time-consuming procedures and expensive cost [12-14]. Otherwise, the electrochemical method was suitable for dopamine detection because dopamine could be easily detected by oxidation at specific potential. However, dopamine detection using the conventional biosensor is not enough to monitor the presence of dopamine accurately when dopamine coexists with uric acid (UA) and ascorbic acid (AA) as interferences which are commonly existed with dopamine in the body. UA and AA are known to be oxidized at the specific potential similar to dopamine which limits the accurate measurement of dopamine [15-19]. Furthermore, the sensitivity of the conventional biosensors is not enough to detect dopamine accurately due to low concentration of dopamine in the body with nanomolar concentration.

To solve these problems, various materials have been employed to modify the electrode including carbon-based materials and metal nanoparticle such as gold and platinum

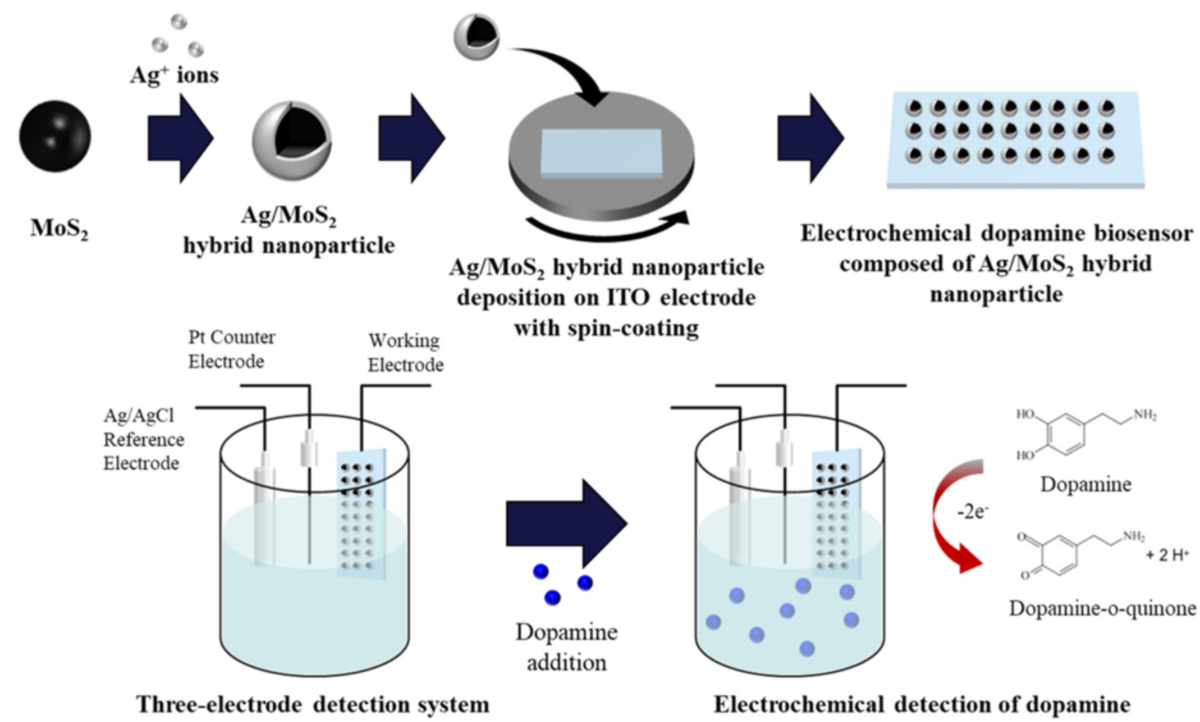

Fig. 1. Schematic diagram of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle fabrication and dopamine detection with three-electrode system.

for enhancement of the sensitivity and selectivity to detect the dopamine [20-22]. Traditional metal materials such as gold and platinum have been widely studied for the enhancement of the electrochemical signal owing to their high conductivity and the electrocatalytic property [23]. Despite these advantages, however, gold and platinum have not been preferred for the biosensor fabrication because of its limitations such as limited resources, low sensitivity and low linearity at low dopamine concentration [24,25]. Therefore, the introduction of alternative materials was required to overcome these limitations. Silver was evaluated as proper material for dopamine detection according to its excellent sensitivity and linearity for low concentrations of dopamine. Likewise, the transition metal dichalcogenide (TMD) materials has gained much attention due to its properties including direct bandgap, optical properties and conductance [26,27]. These properties of the TMD materials was expected to be effective for the development of the dopamine sensors with the advantages like high conductance and sensitivity. Choi's group have been developed the biosensors based on the TMD materials such as MoS_2 and Bi_2Se_3 [28,29]. Furthermore, if a particle with the silver and the TMD material could be fabricated, it would be possible to measure dopamine accurately through the hybridization of the two materials for their properties such as high conductivity and sensitivity, which has never been reported before.

In this paper, the electrochemical biosensor composed of silver encapsulated MoS_2 (Ag/MoS_2) hybrid nanoparticle was fabricated for the first time to detect the dopamine with the electrochemical signal enhancement. The schematic diagram of the electrochemical biosensor composed of Ag/MoS_2 nanoparticle was shown in Fig. 1. Moreover, Ag encapsulated MoS_2 hybrid nanoparticle was utilized to prepare the dopamine biosensor. Due to addition of poly(vinylpyrrolidone) (PVP) during MoS_2 synthesis process, Ag/MoS_2 hybrid nanoparticle could be easily synthesized with simple steps. Nonionic surfactant, PVP, provided conversion of Ag+ ion to Ag nanoparticle on MoS_2 nanoparticle without any additional surfactants [30]. Previous research has introduced silver nanoparticle and graphene oxide based dopamine biosensor with electrochemical deposition method, however, it has disadvantages in that the surface is not uniform [31]. It is difficult to control the size of the silver nanoparticle with electrochemical deposition method, so it is difficult to form a uniform surface. However, with the spin-coating technique, uniformly synthesized Ag/MoS_2 hybrid nanoparticle was applied to the electrode surface. Therefore, well-orientation of Ag/MoS_2 hybrid nanoparticle with uniform size on the indium tin oxide (ITO) electrode surface could be obtained as compared with the electrochemical deposition method. Synthesis of the MoS_2 and

Ag/MoS_2 hybrid nanoparticle was verified by transmission electron microscopy (TEM) and energy-dispersive X-ray spectroscopy (EDS). Fabrication of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was confirmed by field emission scanning electron microscopy (FE-SEM) and EDS. Electrochemical investigation for dopamine detection are confirmed by cyclic voltammetry (CV), differential pulse voltammetry (DPV) and amperometric i-t curve technique.

2. Materials and Methods

2.1. Materials

Silver (I) nitrate solution ($AgNO_3$) was purchased from Daejung Chemical & Metals (Korea). Ammonium molybdate tetrahydrate ($H_{24}Mo_7N_6O_{24}·4H_2O$) was purchased from Sigma-Aldrich (USA). Thiourea (H_2NCSNH_2) was purchased from Amresco, Inc. (USA). Poly(vinylpyrrolidone) was purchased from Fluka™ (USA). Phosphate buffered saline (PBS) (pH 7.4, 10 mM) solution used as the electrolyte in this study and triton X-100 solution were obtained from Sigma-Aldrich (USA). All aqueous solutions were prepared using deionized water (DIW) from a Millipore Milli-Q water purifier (Millipore, USA) operating at a resistance of 18 MΩ/cm. Dopamine, AA and UA were purchased from Sigma-Aldrich (USA).

2.2. MoS_2 nanoparticle and Ag/MoS_2 hybrid nanoparticle synthesis

To prepare the MoS_2 nanoparticle, first of all, 0.35 g ammonium molybdate tetrahydrate, 0.76 g thiourea and 0.25 g PVP were dissolved in DIW by magnetic strring for 30 min. Then, the mixed solution was put into a 100 mL Teflon-lined hydrothermal reactor and heated at 200°C for 24 h. After this process, the impurities or aggregated MoS_2 nanoparticle were filtered by filter paper and the product solution was dried in the oven at 80°C for 12 h. Acquired MoS_2 nanoparticle was washed with the DIW and ethanol for several times.

To synthesis the Ag/MoS_2 hybrid nanoparticle, prepared MoS_2 nanoparticle was dissolved in DIW at a concentration of 0.34 mM with sonication for 30 min. Then, 50 μL of $AgNO_3$ aqueous solution (25 mM) was added to prepared MoS_2 colloidal solution with magnetic stirring for 10 min at room temperature. After reaction, the final product was collected from the mixed solution after centrifugation at 13,000 rpm and sonic cleaning for five times. Acquired MoS_2 nanoparticle and Ag/MoS_2 hybrid nanoparticle was characterized by high-resolution TEM (HR-TEM) using JEOL JEM-3010 operated at 200 kV with EDS mapping technique.

2.3. Deposition of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle

ITO electrode (length: 10 mm, width: 10 mm) was cleaned by sonication for 30 min using triton-X 0.1% solution, DIW and ethanol sequentially. Then, washed ITO electrode was full dried by N_2 gas. To fabricate the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle, prepared Ag/MoS_2 hybrid nanoparticle colloidal solution (1 mg/1 mL) was spin-coated on the cleaned ITO electrode at 3,000 rpm for 30 s. The spin-coated ITO electrode was dried in air for 10 min at room temperature. Fabricated electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was characterized by FE-SEM using JEOL JSM-7100F with EDS point technique.

2.4. Dopamine detection using the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle

Electrochemical investigation of the fabricated electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was performed using a potentiostat (CHI-660E, CH Instruments, Inc., USA) to investigate the dopamine detection with electrochemical signal enhancement. CV, DPV and amperometric i-t curve technique were performed using a three-electrode system consisted with the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle as a working electrode, a platinum (Pt) wire electrode as the counter electrode and a silver/silver chloride (Ag/AgCl) electrode as the reference electrode. The PBS solution was used as the electrochemical buffer solution for electrochemical measurement. As parameters, the sensitivity of 1.0×10^{-6} A/V, the scan rate of 100 mV/s, the quiet time of 2 s and sample interval of 1 mV were applied. The range of applied potential voltage for CV and DPV was from -0.4 V to 0.6 V. As parameters for the operation of the amperometric i-t technique, -0.3 V, 0.1 s and 1.0×10^{-6} A/V for initial potential, sampling interval and sensitivity were applied, respectively. The chemical neurotransmitters, dopamine, UA and AA, were dissolved in PBS at various concentrations of dopamine and 10 μM for UA and AA.

3. Results and Discussion

3.1. Confirmation of synthesized MoS_2 nanoparticle and Ag/MoS_2 hybrid nanoparticle

The synthesis of MoS_2 nanoparticle and Ag/MoS_2 hybrid nanoparticle were confirmed by HR-TEM and EDS accompanying mapping. The HR-TEM image of the MoS_2 nanoparticle was shown in Fig. 2A. The synthesized MoS_2 nanoparticle have a 150 nm average diameter. EDS and EDS mapping was performed to confirm that MoS_2 nanoparticle was successfully synthesized. Fig. 2B showed the EDS mapping results of the MoS_2 nanoparticle. In EDS mapping images, molybdenum (Mo) and sulfide (S) were displayed following the located synthesized MoS2 nanoparticle. The EDS result of MoS_2 nanoparticle was shown in Fig. 2E. The apparent peaks of Mo and S were shown in the EDS result. Also, the amount of Mo and S were 30.97% and 69.03%, respectively. The ratio of Mo and S was approximately 1:2 which confirmed that that MoS_2 nanoparticle was successfully synthesized.

Since PVP was added during the synthesis process, MoS_2 nanoparticle was easily encapsulated by Ag. The outside of synthesized MoS_2 nanoparticle was covered by PVP. PVP is an important nonionic surfactant and could make the Ag nanoparticles homogeneously dispersed on the surface of MoS_2 nanoparticle. In addition, PVP prevents the aggregation of Ag nanoparticles, so that uniform Ag/MoS_2 hybrid nanoparticle could be synthesized. Fig. 2C showed HR-TEM image of the Ag/MoS_2 hybrid nanoparticle. The average diameter of the Ag/MoS_2 hybrid nanoparticle was 150 nm. The EDS mapping images were shown in Fig. 2D.

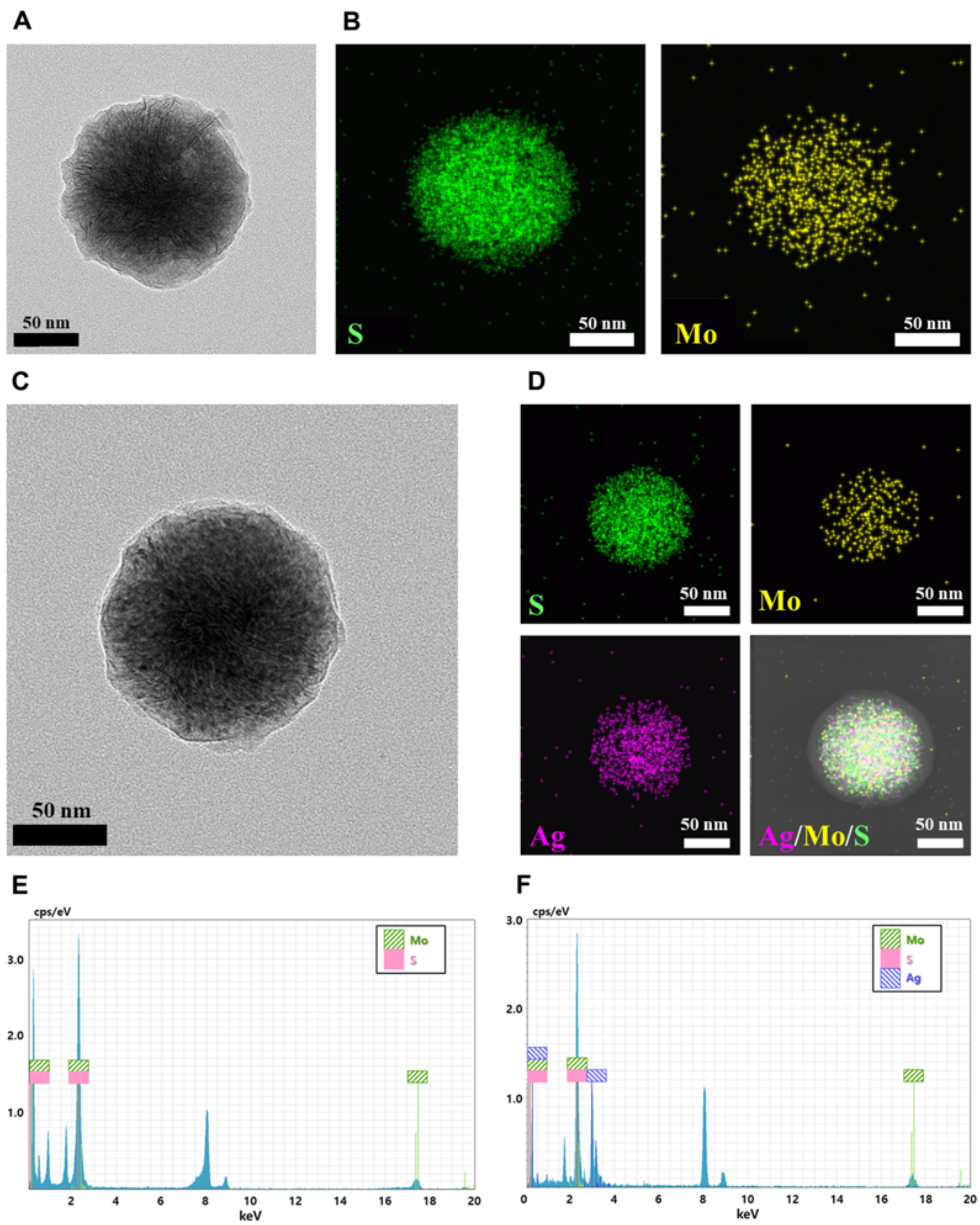

Fig. 2. HR-TEM images of MoS_2 nanoparticle and Ag/MoS_2 hybrid nanoparticle; (A) HR-TEM image and (B) EDS mapping images of MoS_2 nanoparticle; (C) HR-TEM image and (D) EDS mapping images of Ag/MoS_2 hybrid nanoparticle; EDS result of (E) MoS_2 nanoparticle, (F) Ag/MoS_2 hybrid nanoparticle.

Unlike the case of the MoS_2 nanoparticle, the EDS mapping images of Ag/MoS_2 hybrid nanoparticle showed that MoS_2 nanoparticle was covered by Ag nanoparticles. The EDS result of Ag/MoS_2 hybrid nanoparticle was shown in Fig. 2F. The apparent peaks of Mo, S and Ag were shown in the EDS result. The amount of Mo, S and Ag were 23.73%, 48.08% and 28.19%, respectively. From the EDS result, it was confirmed that Ag nanoparticle was successfully added while the ratio of Mo and S, approximately 1:2, was maintained. Therefore, with these results, it was confirmed that Ag/MoS_2 hybrid nanoparticle was successfully synthesized.

3.2. Structure of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle

The synthesized Ag/MoS_2 hybrid nanoparticle was dissolved in DIW and spin-coated on the ITO electrode to fabricate the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. The structure of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was verified with FE-SEM and EDS. Fig. 3 showed the FE-SEM images of the bare electrode, the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle and magnified electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. Compared to the bare electrode, homogeneous size of Ag/MoS_2 hybrid nanoparticles were deposited on the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle as shown in Fig. 3A and 3B. As shown in Fig. 3B, Ag/MoS_2 hybrid nanoparticles were uniformly distributed on the ITO electrode surface by the introduction of the spin-coating method. Additionally, Fig. 3C showed magnified FE-SEM image of deposited Ag/MoS_2 hybrid nanoparticle. In the magnified FE-SEM image, Ag could be found on the MoS_2 nanoparticle as a small dot. EDS was performed to confirm that the covered nanoparticles were the synthesized Ag/MoS_2 hybrid nanoparticle. The EDS result of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was shown in Fig. 3D. As the EDS result of Ag/MoS_2 hybrid nanoparticle, the peaks of Mo, S and Ag were shown in the EDS result of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. Furthermore, the amount of Mo, S and Ag were 25.04%, 48.73% and 26.23%, respectively. With these results, the nanoparticle deposited on the ITO electrode in Fig. 3B and 3C were confirmed as the synthesized Ag/MoS_2 hybrid nanoparticle.

3.3. Enhanced electrochemical dopamine signal of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle

The electrochemical dopamine signal enhancement of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was verified by comparison between the bare electrode, Ag covered electrode, MoS_2 covered electrode and the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle using CV technique. CV was performed with 10 μM dopamine dissolved in PBS. Fig. 4A showed the cyclic voltammogram comparison between the bare electrode, Ag covered electrode, MoS_2 covered electrode and the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. Dopamine was detected at the oxidation peak (0.300 V). For the comparison of dopamine signal

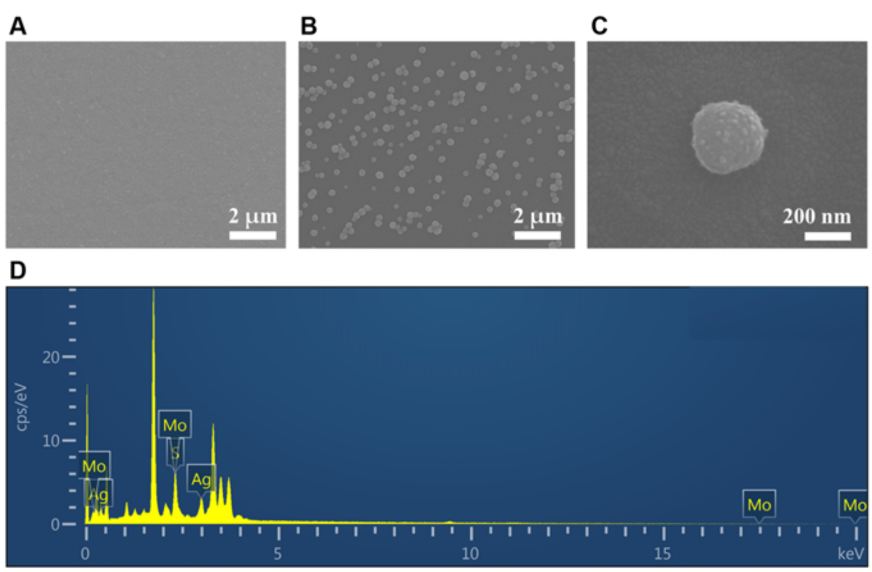

Fig. 3. FE-SEM images of (A) the bare electrode, (B) the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle and (C) magnified electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle, (D) EDS result of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle.

enhancement, the oxidation peak current of dopamine was used throughout the experiment. Fig. 4B showed the comparison of the absolute oxidation peak current values provided different electrodes. As shown in Fig. 4B, the electrochemical dopamine signal was significantly enhanced with the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. The electrochemical signals of Ag covered electrode and MoS_2 covered electrode by dopamine were also increased compared to the bare electrode, however, the electrochemical signal of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle by dopamine was much more increased than other electrodes. This electrochemical signal enhancement was due to the properties of Ag and MoS_2 nanoparticle. Ag nanoparticle has great conductivity and can detect the dopamine at low concentration. MoS_2 nanoparticle has excellent physical and chemical properties. MoS_2 nanoparticle could increase the electrochemical capacity and cycling performance due to its layered structure [32,33]. Importantly, MoS_2 nanoparticle could exhibit enhanced electrochemical performance when synthesized with other materials such as metal nanoparticles and carbon-based nanoparticles [34,35]. Thus, with these properties, the Ag/MoS_2 hybrid nanoparticle could enhance the conductivity of the electrode, so, the electrochemical dopamine signal could be enhanced. Furthermore, by introduction of Ag/MoS_2 hybrid nanoparticle on the ITO electrode surface, the enlargement of the electroactive surface may affect the electrochemical signal enhancement.

Additionally, silver nanoparticle modified electrode covered by graphene oxide developed by Choi's group was fabricated by the electrochemical deposition method, so, the surface of the electrode was not uniform. The size of Ag nanoparticle was difficult to controlled and the reproducibility was low when the electrochemical deposition method was used. However, by the introduction of the spin-coating method, this prepared biosensor showed the well-orientation of Ag/MoS_2 hybrid nanoparticle. and high reproducibility. However, direct comparison of silver nanoparticle modified electrode covered by graphene oxide in previous research and this Ag/MoS_2 hybrid nanoparticle covered electrode was not appropriate since two electrodes were fabricated with different method. Therefore, silver nanoparticle and graphene oxide were spin-coated on the ITO electrode to compare with this biosensor for confirmation of the electrochemical signal enhancement. Fig. 4C and 4D showed cyclic voltammogram and oxidation peak current of silver nanoparticle modified electrode covered

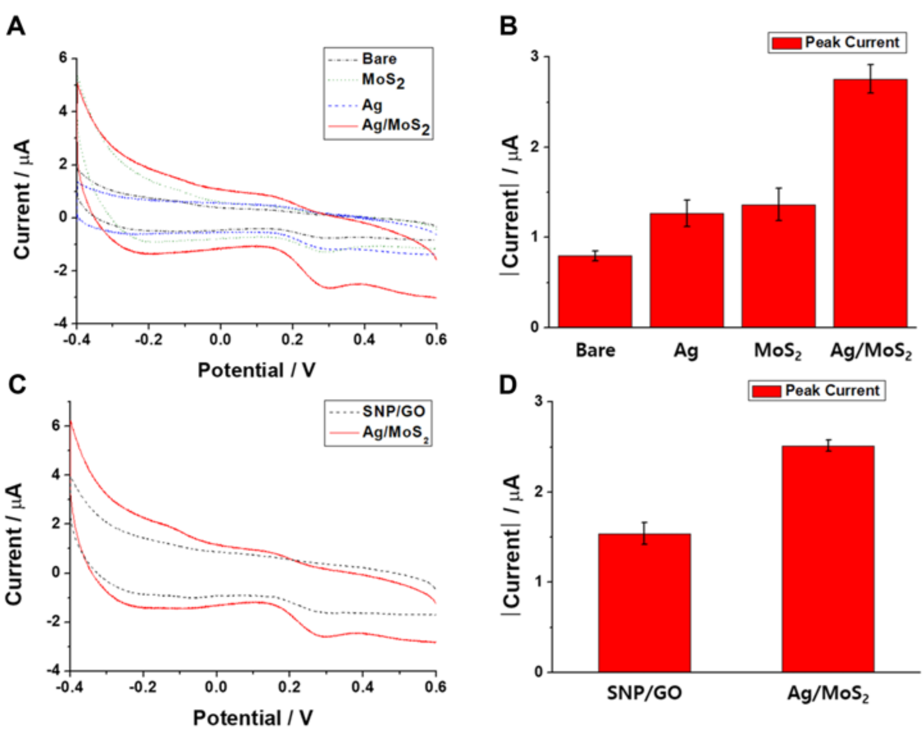

Fig. 4. (A) Cyclic voltammogram of bare electrode, Ag covered electrode, MoS_2 covered electrode and the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. (B) Absolute peak current comparison between bare electrode, Ag covered electrode, MoS_2 covered electrode and the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. (C) Cyclic voltammogram of silver nanoparticle modified electrode covered by graphene oxide (SNP/GO) and the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. (D) Absolute peak current comparison between SNP/GO and the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle; The concentration of dopamine was fixed to 10 µM.

by graphene oxide and electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. The absolute oxidation peak current of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was higher than that of silver nanoparticle modified electrode covered by graphene oxide. Therefore, it was verified that Ag/MoS_2 hybrid nanoparticle was more suitable for dopamine detection than only silver nanoparticle existed electrode or only graphene oxide existed electrode. From these results, it was verified that introduction of Ag/MoS_2 hybrid nanoparticle and spin-coating method induced the well-oriented uniform surface and enhanced electrochemical signal.

3.4. Selectivity and sensitivity test of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle

To verify the dopamine detecting performance of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle, the amperometric i-t curve and DPV technique were performed. AA and UA coexist with dopamine in the body and exhibit similar electrochemical properties of dopamine. Hence, efficient selective detection of dopamine in presence of AA and UA is important for dopamine detection. With this reason, for confirmation of selective property of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle, dopamine, AA and UA were sequentially added to PBS buffer during the amperometric i-t curve technique. The concentration of dopamine, AA and UA were fixed to 10 μM. Fig. 5A showed efficient amperometric response of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. When dopamine was added, the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle exhibited the amperometric response. However, when AA and UA were added, short amperometric response was exhibited but current didn't represent any change after stabilized. This recovery effect was caused by the mechanical add-on process. When AA and UA were injected, the flow temporarily occurs and the current increases temporarily, but it stabilizes soon. For further confirmation of selectivity, DPV technique was employed as shown in Fig. 5B. It was confirmed that the peak current increased as dopamine concentration increased when concentration of AA and UA were fixed at 10 μM. The concentration of dopamine was increased from 0 μM to 10 μM by 2 μM intervals. As shown in Fig. 5A and

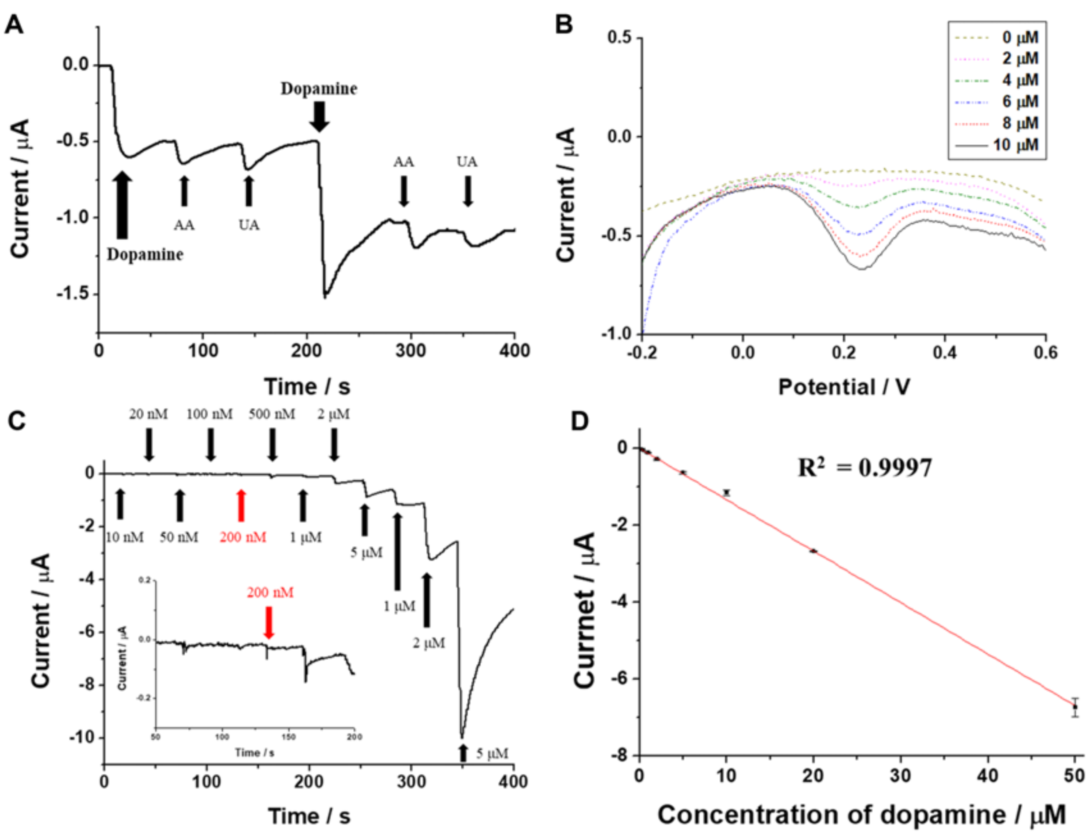

Fig. 5. (A) Amperometric i-t measurement to continuous addition of 10 μM dopamine, AA and UA. (B) DPV measurement for the concentration of dopamine from 0 μM to 10 μM in presence of 10 μM AA and UA. (C) Amperometric i-t dopamine response with the addition of various dopamine concentrations to the PBS buffer. (D) Linear curve of the oxidation peak current values and concentration of dopamine (n = 3).

Table 1. Comparison of some electrochemical characteristics of the different Ag-based or MoS_2-based electrodes for dopamine detection

Electrode	Methods	Linear range (μM)	Detection limit (μM)	Reference
Ag/GCE[1]	DPV	10-60	0.5	[36]
PABSA-rMOS_2[2]/CPE[3]	DPV	1-50	0.22	[37]
Au/MoS_2-NSs[4]	DPV	5.0-200	1.0	[38]
MoS_2-RGO[6]	DPV	1.5-100	0.94	[39]
Ag-CNT[5]/CPE	DPV	0.8-64	0.3	[40]
Ag/MoS_2	CV, AM	0.2-50	0.2	This work

[1]Glassy Carbon Electrode; [2]poly(m-aminobenzenesulfonic acid)-reduced MoS_2; [3]Carbon Paste electrode; [4]Nanosheets; [5]Carbon Nanotube; [6]Reduced Graphene Oxide.

Fig. 5B, the efficient selective dopamine detection of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was confirmed in presence of AA and UA.

To confirm the detection limit of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle, the amperometric i-t curve technique was conducted with additions of various dopamine concentrations (0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 and 50 μM). As the parameter for the initial potential, 0.300 V was chosen to achieve the complete oxidation state of dopamine. Fig. 5C showed the result of amperometric i-t curve with the additions of dopamine to the PBS buffer. The current value maintained at about 202 μA until 0.1 μM of dopamine was added, however, the current value increased to 275 μA when 0.1 μM of dopamine was added. After the first response to dopamine, the current value was continuously increased with the addition of increasing concentration of dopamine. With this result, the detection limit of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was estimated to 0.2 μM. Additionally, the linearity of the concentration of dopamine and the peak current was verified by comparison of those values obtained by the amperometric i-t curve technique. As shown in Fig. 5D, the peak values and the concentration of dopamine exhibited excellent linearity in the concentration range of 0.2 μM to 50 μM. The coefficient of determination value (R^2) was 0.9997 which exhibited the excellent linearity. Average values and error bars were acquired by the standard deviation (SD) of three measurements. The detection limit of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was compared to other electrodes. Table 1 showed the comparison of Ag/MoS_2 hybrid nanoparticle covered electrode to other electrodes.

4. Conclusion

In this study, the electrochemical dopamine biosensor composed of Ag/MoS_2 hybrid nanoparticle on the ITO electrode was fabricated for detection of dopamine with enhanced electrochemical properties for high sensitivity and selectivity. To achieve this, for the first time, MoS_2 nanoparticle was encapsulated by Ag nanoparticle to synthesize Ag/MoS_2 hybrid nanoparticle. Synthesized Ag/MoS_2 hybrid nanoparticle was spin-coated on the ITO electrode to fabricate the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle. Synthesized MoS_2 nanoparticle and Ag/MoS_2 hybrid nanoparticle were confirmed by HR-TEM and EDS accompanying mapping. The surface morphology of fabricated electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was confirmed by FE-SEM and EDS. The electrochemical signal enhancement of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle by dopamine detection was confirmed by CV and the comparison of absolute oxidation peak current between other electrodes. The detection limit of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was 0.2 μM and linear range was 0.2-50 μM while other electrodes exhibited higher detection limit or narrower linear range. The selectivity of this biosensor was confirmed by amperometric i-t curve technique with continuous addition of dopamine, and DPV investigation with presence of AA and UA. Estimation of dopamine detecting sensitivity of the electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle was done by amperometric i-t curve technique with continuous addition of dopamine. The detection limit was estimated 0.2 μM. Excellent linearity between the concentration of dopamine and the peak current was confirmed by the comparison of those values obtained by amperometric i-t curve technique in range of 0.2 μM to 50 μM. In conclusion, our newly developed electrochemical biosensor composed of Ag/MoS_2 hybrid nanoparticle on the ITO electrode could be used as the biosensing platform to develop the various biosensors with electrochemical signal enhancement.

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