Characterization of Electrochemically Polymerized Dopamine

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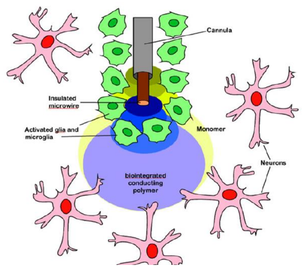
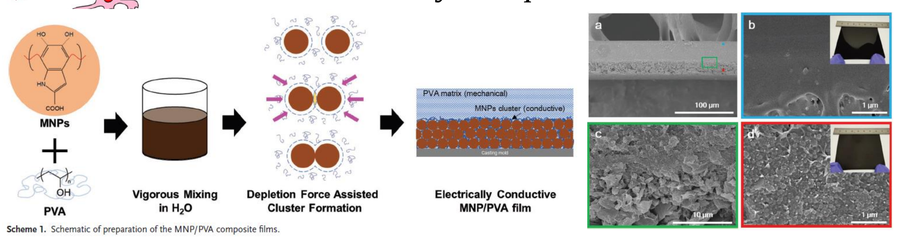
Abstract

Melanin is a natural material that has been considered for organic bioelectronic applications because of its non-toxicity, adhesion to inorganic surfaces, and stability in aqueous environments. Poly(dopamine) is a melanin analog that can be prepared by electrochemical deposition. Here, we demonstrated the ability to prepare conductive poly(dopamine) films by electrochemical polymerization onto gold electrodes. The structure and properties of these films were investigated through electrochemical impedance spectroscopy (EIS), optical microscopy (OM), scanning electron microscopy (SEM), atomic force microscopy (AFM), and in situ transmission electron microscopy (in situ TEM). The low frequency impedance was significantly reduced by the dark poly(dopamine) films that were formed on the gold electrodes.

Introduction



Conductive polymers can improve interactions between metallic electrode and living cells with high ionic/electronic conductivity in bioelectronics. Melanin has been studied as a natural material with non-toxicity, high adhesion to inorganic surfaces, and stability in aqueous environments.

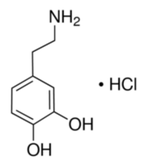


Scheme 1. Schematic of preparation of the MNP/PVA composite films.

Martin, David C. 2015. *MRS Communications* 5 (2): 131–53.
Eom, et al. 2019. *Particle & Particle Systems Characterization* 36 (10): 1900166.

Experimental

Electrode : DRP-C223AT
(W, C: Gold, R: Silver)



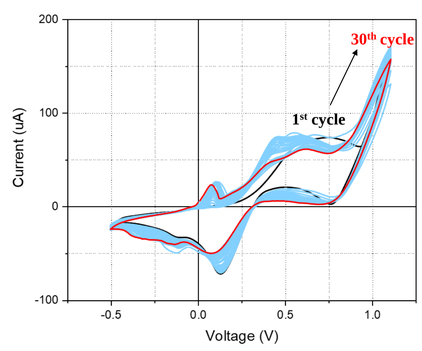
Dopamine hydrochloride
(Sigma-H8502)

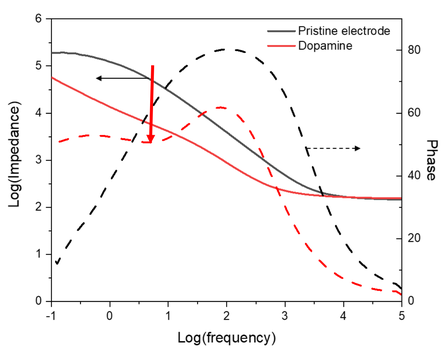
Poly(dopamine) was synthesized via cyclic voltammetry (-0.5 ~ 1.1 V, 30 cycles, 100 mV/s) with 20 mM dopamine in DI water. Synthesized polydopamine was observed by optical microscopy, AFM, and FIB-SEM.

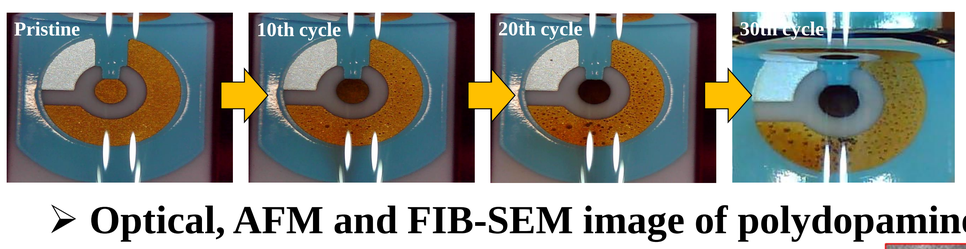
In situ TEM experiment was performed via cyclic voltammetry (-0.5 ~ 1.1 V, 8 cycles, 100 mV/s) using Hummingbird sample holder with 20 mM dopamine solution. The flow rate of solution was 0.1 uL/min.

Results and Discussions

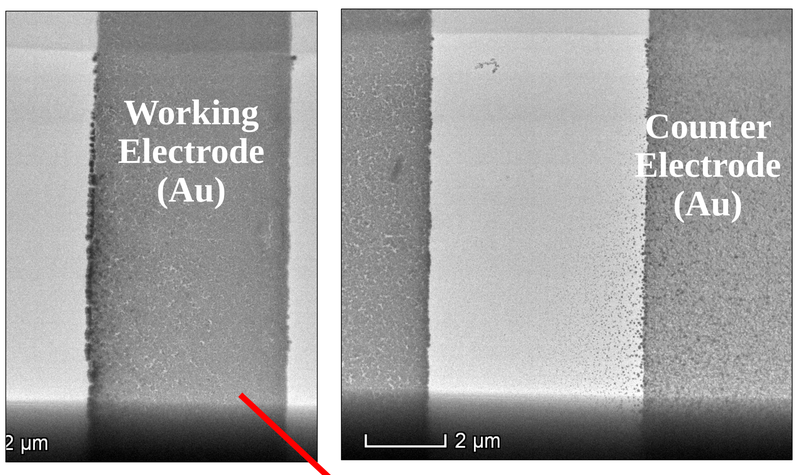
➢ Cyclic Voltammetry and Impedance Spectroscopy

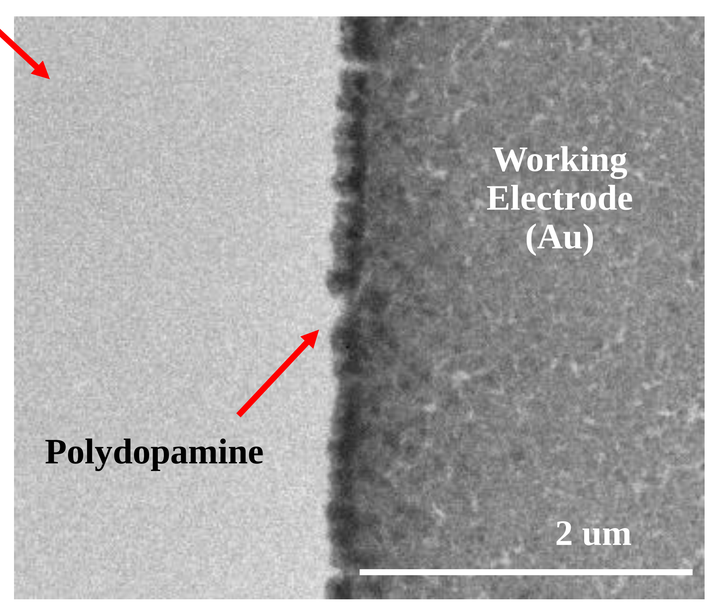




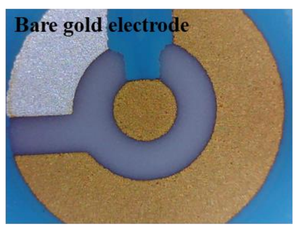


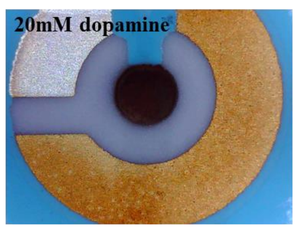
➢ In situ TEM

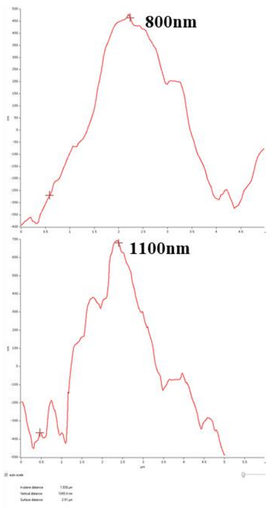


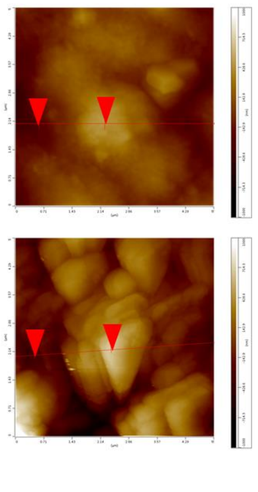


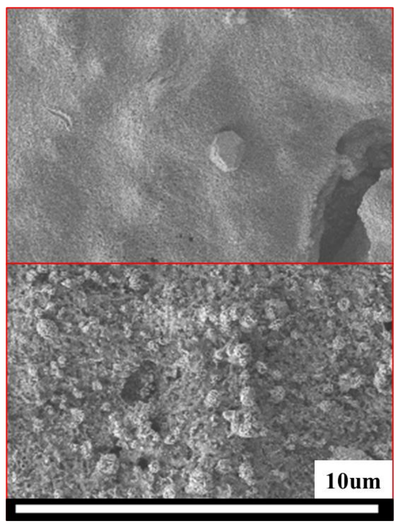
➢ Optical, AFM and FIB-SEM image of polydopamine

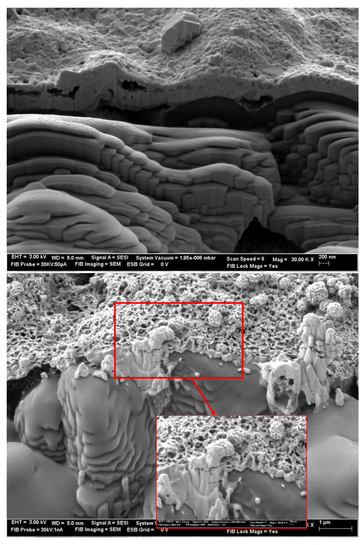












Conclusions

- Polydopamine was successfully synthesized via the electrochemical method on gold electrodes and morphology was observed through AFM, FIB-SEM, and in situ TEM.
- The impedance of polydopamine coated gold electrode was significantly decreased in the low frequency regime below 1 kHz.

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