DEVELOPMENT OF MODIFICATION TECHNIQUE OF GCE WITH METALL-ORGANIC FRAMEWORKS FOR THE ELECTROCHEMICAL DETECTION OF DOPAMINE

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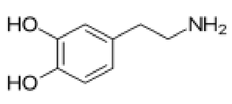
1. Introduction. Importance of Dopamine sensor

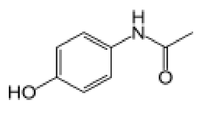
Dopamine (DA) is an important neurotransmitter for nervous system. Disorders in secretion lead to Parkinson's disease, schizophrenia, etc [1].

In real probe:

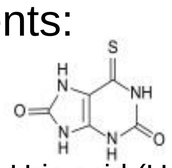


DA (target analyte)

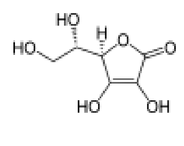
Interfering agents:



Paracetamol (PA)



Uric acid (UA)



Ascorbic acid (AA)

High selectivity
High sensitivity
Availability
Expressiveness

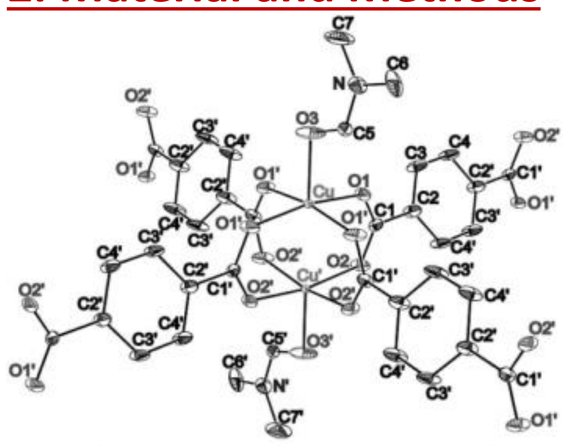
→ Electrochemical sensor

→ An electrocatalyst (for separation of analytical signals)

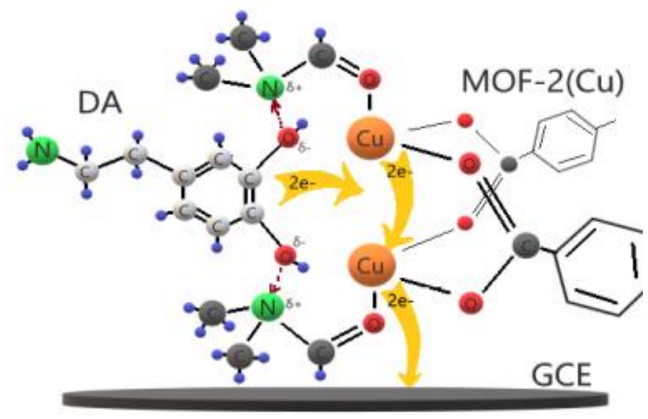
→ Metal-organic frameworks (MOF)

→ An effective dopamine adsorbent (for sensitivity)

2. Material and Methods



The crystal structure for $[Cu_2(C_8H_4O_4)_2(DMF)_2]$ (MOF-2(Cu)) [2]



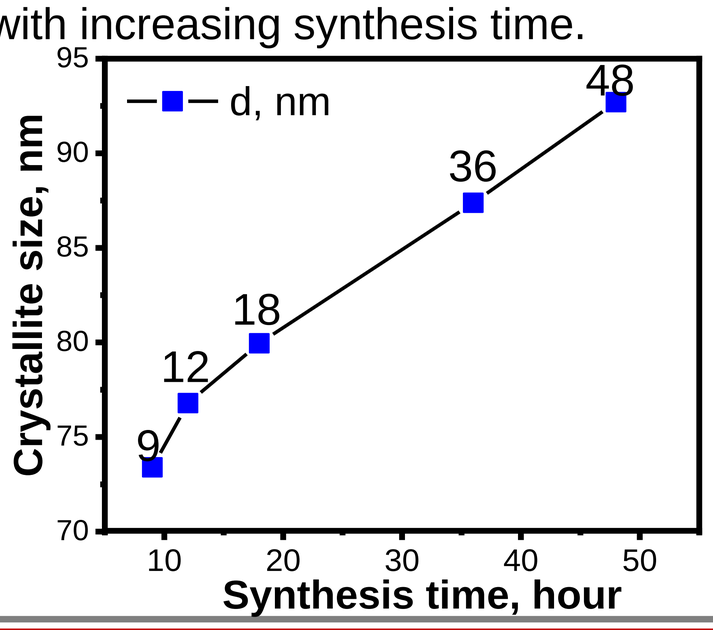
The proposed mechanism of dopamine adsorption and its electrocatalytic oxidation at metal centers

$Cu\ (III) + e^- \leftrightarrow Cu\ (II)$

The crystallite size determines the number of available DA adsorption centers on the surface of the modified GCE. The size of the crystallite is determined by the synthesis time. MOF-2(Cu) was synthesized by the solvothermal method [2]. The drop casting technique of glassy carbon electrode (GCE) modification was used in this work.

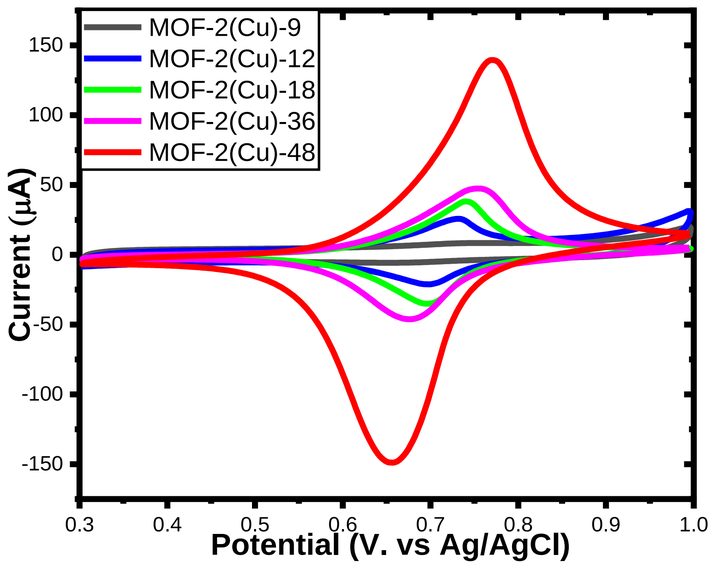
3. Results. Design of crystallite size

It was found experimentally that the crystallite size of MOF-2(Cu) growths with increasing synthesis time.

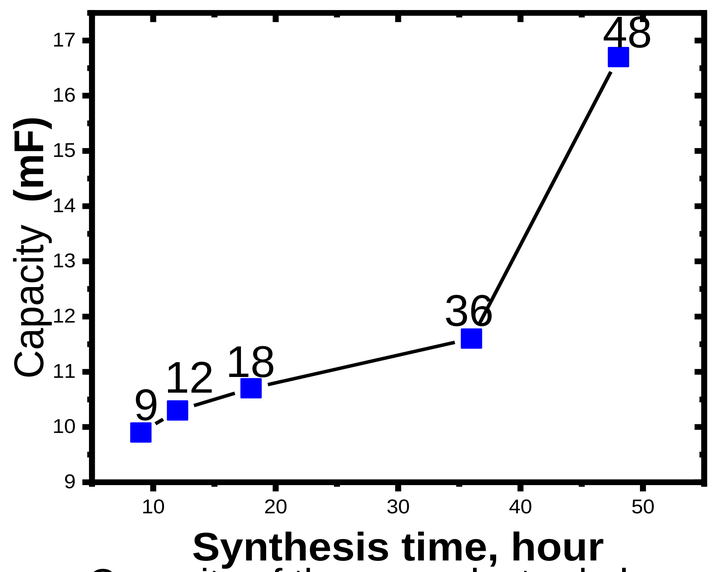


Electrocatalytic activity

The growth of the crystallite size is accompanied by an increase of the surface area and the number of available electrocatalytic centers.



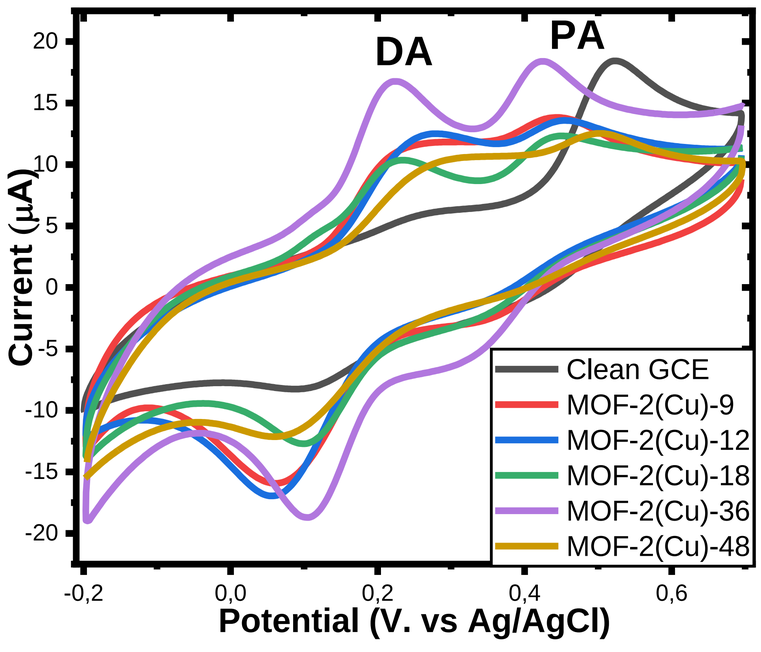
CVs of ferrocyanide oxidation reactions



Capacity of the near-electrode layer

Dopamine sensitivity

The number of available adsorption centers for dopamine passes through a maximum with increasing crystallite size. This sensitivity maximum corresponds to a crystallite size of 87 nm and a synthesis time of 36 hours.

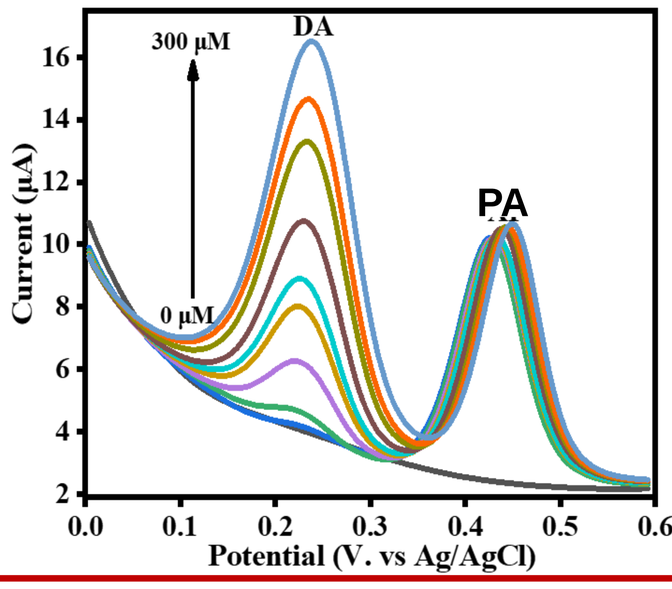


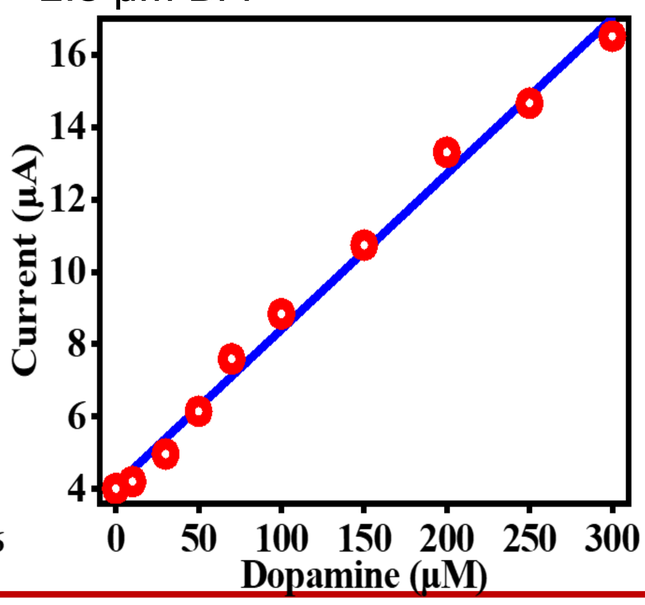
CVs recorded in 0.1 M PBS (pH 7.4), 300 μM DA and 600 μM PA

Metrological characteristics

Calibration equation: I (μA) = 0.039[DA] (μM) + 4.790

Linear range: 5-300 μM DA, LOD = 2.3 μM DA





DPVs recorded in 0.1 M PBS (pH 7.4), 600 μM PA and 0-300 μM DA

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References:

[1] Moon J.M. et al. Conducting polymer-based electrochemical biosensors for neurotransmitters: A review // Biosens. Bioelectron. Elsevier B.V., 2018. Vol. 102, № September 2017. P. 540–552.

[2] Carson C.G. et al. Synthesis and structure characterization of copper terephthalate metal-organic frameworks // Eur. J. Inorg. Chem. 2009. № 16. P. 2338–2343.