Sensorial activity determination of the human catechol-O-methyl transferase at fluorine doped tin oxide

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1 Introduction

The catechol-O-methyl transferase (COMT) has become of research interest since it is involved in the dopamine metabolism. This is disturbed in several neurodegenerative diseases such as Morbus Parkinson. Thus, a fast and reliable method for the activity measurement of this enzyme is needed. One approach is focused on the direct detection of substances involved in the biocatalytic conversion.

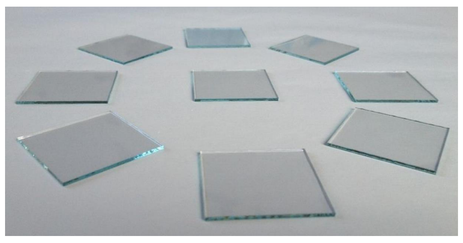
Due to their redox activity catecholamines can be detected by electrochemical methods. Carbon-based electrodes reveal a high sensitivity for dopamine and other catecholamines and are frequently used for their detection. However, often polymerization products of the oxidized dopamine cause a passivation of the electrode surface. Another drawback is the oxidation current from interferents in physiological samples superimposing the current signal from dopamine at carbon electrodes.

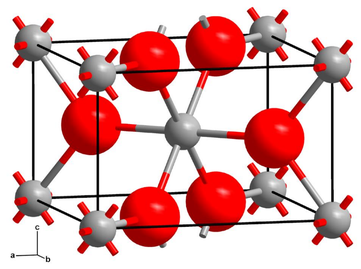
With this respect fluorine doped tin oxide (FTO) is investigated as electrode material for activity determination of the COMT.

2 Fluorine doped tin oxide

Properties

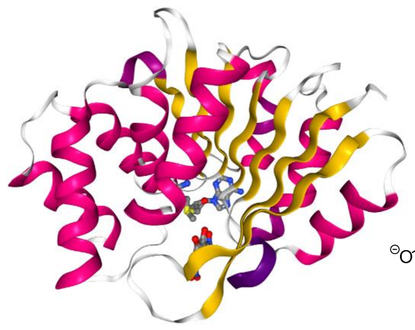
- Electrically conductive
- Sheet resistance 7 Ω/sq
- Chemically inert
- Mechanically hard
- High-temperature resistant
- Less expensive than indium tin oxide



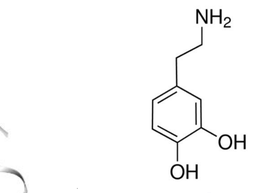


SnO_2

3 Catechol-O-methyl tranferase (COMT)

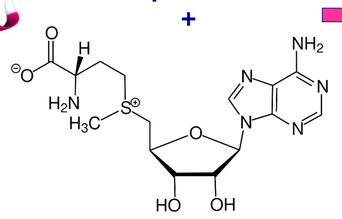


Structure

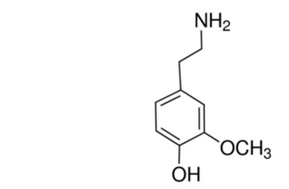


Dopamine

+

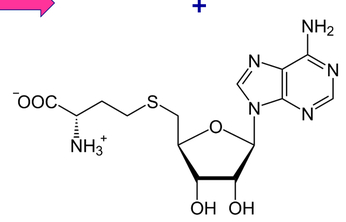


S-adenosyl-L-methionine (SAM)



3-Methoxytyramine

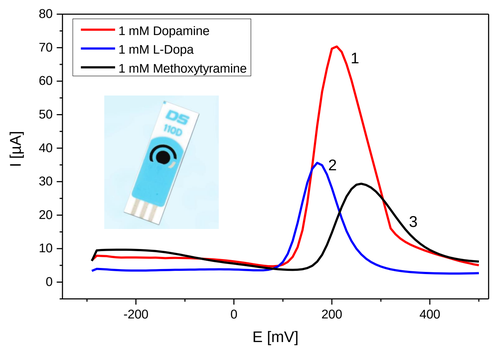
+



S-adenosyl-L-homocysteine

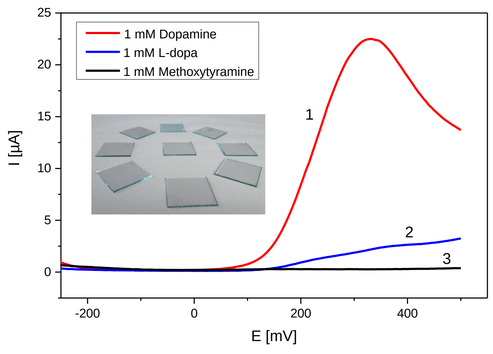
4 Discrimination of dopamine metabolites at CNT and FTO

DPV at SWCNT-modified carbon



→ Current signal of L-Dopa and methoxytyramine in the potential range of the peak current of dopamine
→ No discrimination feasible

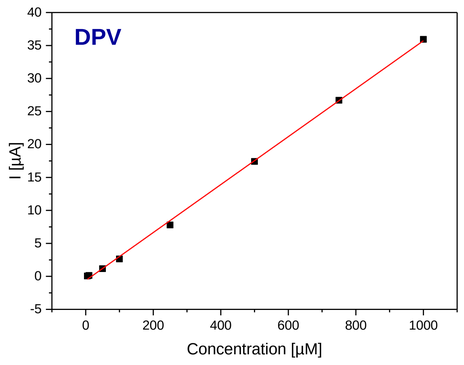
DPV at FTO



→ No oxidation current of methoxytyramine
→ Significantly decreased oxidation current for L-dopa
→ Allows exclusive dopamine detection

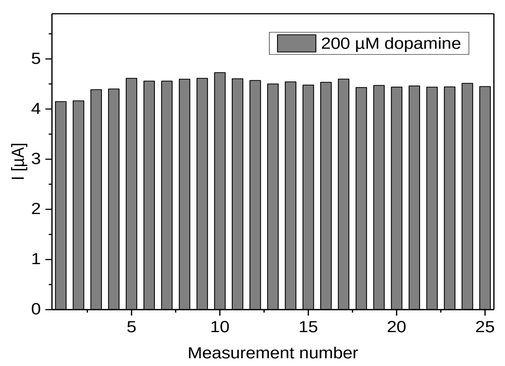
5 Sensing characteristics of FTO for dopamine detection

Sensitivity



→ Linear dependency of the peak current on the dopamine concentration in the range from 5 µM to 1 mM

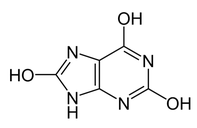
Stability



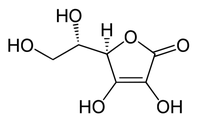
→ No significant change of the signal intensity for dopamine

6 Voltammetric behaviour of interferents for dopamine detection at FTO

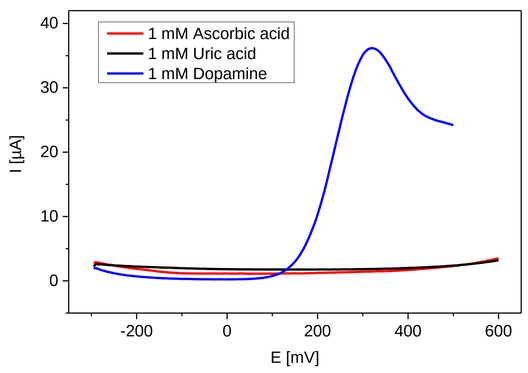
Uric acid



Ascorbic acid



DPV at equal concentrations



→ No oxidation current of ascorbic acid and uric acid in the potential range of the peak current of dopamine

7 Detection of COMT activity at FTO

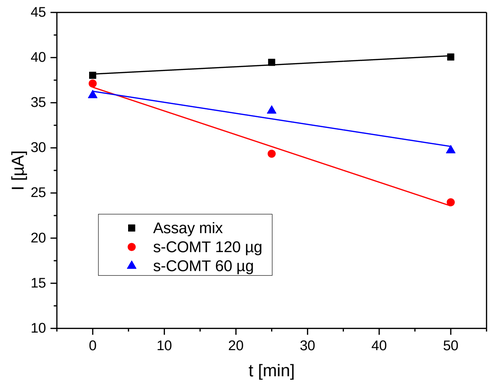
Time course of COMT action:

- Determination of dopamine concentration during COMT catalyzed conversion:

→ Decreasing dopamine concentration verifies COMT action

- Variation of the enzyme amount:

→ Reaction rate depends on the COMT concentration



8 Conclusions

- FTO provides a good basis for the electrochemical detection of dopamine
- Linear dependency of the electrochemical signal on the concentration of dopamine up to 1 mM
- Voltammetric dopamine detection is not disturbed by the precursor L-Dopa and by typical interferents in physiological samples – ascorbic and uric acid
- Oxidation signal of dopamine is significantly more stable compared to the most reported sensor constructions
- FTO allows the construction of reusable dopamine sensors
- FTO can be applied for activity measurements of the COMT

Acknowledgement

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