

# **Electrochemical behaviour of boron-doped diamond electrodes**

by

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## **SYNOPSIS**

Conducting diamond electrodes provide unique advantages for electrochemistry such as a wide potential window, low baseline current, chemical inertness and resistance to fouling. De Beers boron-doped diamond electrodes, manufactured by chemical vapour deposition and containing varying amounts of boron, were therefore investigated in order to determine their suitability for future electrochemical applications. These electrodes were initially characterised using techniques such as SEM, LA-ICP-MS, Raman spectroscopy and XPS. The electrochemical behaviour of these electrodes was investigated in two redox systems (potassium iron (III) cyanide and cerium (III) sulphate) and two biological systems (dopamine and ascorbic acid). These results were compared against that of the conventional glassy carbon electrode. Porous boron-doped diamond, a novel electrode material, was used for the electrochemical detection of thyroid hormones (L-T<sub>3</sub> and L-T<sub>4</sub>).

These hormones have never previously been investigated using a boron-doped diamond electrode.

The De Beers boron-doped diamond electrode was found to outperform the conventional glassy carbon electrode, which fouled very easily, in the detection of dopamine. Peak separation between dopamine and the interfering ascorbic acid was attained at a pretreated boron-doped diamond electrode. The feasibility of detecting thyroid hormones using a porous boron-doped diamond electrode was demonstrated, and the electrode material was patented.

# **Elektrochemiese gedrag van boorbevattende diamantelektrodes**

**deur**

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## **SAMEVATTING**

Geleidende diamantelektrodes lewer unieke voordele in elektrochemie, soos 'n wye potensiaalgebied, 'n lae basislyn, onreaktiewe chemiese eienskappe, en 'n weerstand teen die vorming van 'n neerslag op die oppervlakte, wat die elektrodewerking belemmer. De Beers se boorhoudende diamantelektrodes, wat verskeie hoeveelhede boor bevat, is ondersoek met die doel om hul geskiktheid vir toekomstige elektrochemiese toepassings te bepaal. Hierdie elektrodes is berei deur die neerslag van koolstof in die dampfase in die teenwoordigheid van boor. Dit is aanvanklik gekarakteriseer deur gebruik te maak van tegnieke soos SEM, Raman spektroskopie en XPS. Hierdie elektrodes is getoets in twee redokssisteme (kalium yster(III)sianied en serium(III)sulfaat) en twee biologiese sisteme (dopamien en askorbiensuur). Die verkreë resultate is vergelyk met dié van konvensionele glasagtige koolstofelektrodes. Porieuse boorbevattende diamant, 'n unieke

elektrodemateriaal, is aangewend vir die elektrochemiese bepaling van skildklierhormone (L-T<sub>3</sub> en L-T<sub>4</sub>). Hierdie hormone is nog nie voorheen bepaal deur gebruik te maak van hierdie tipe elektrode nie.

De Beers se boorhoudende diamantelektrode het die werking van die gewone glasagtige koolstofelektrode oorskry; by laasgenoemde vorm 'n aanpaksel op die elektrodeoppervlakte baie geredelik in die bepaling van dopamien. Die skeiding van dopamien en belemmerende askorbiensuur, is bewerkstellig deur gebruik te maak van hierdie elektrodes. Die moontlikheid om skildklierhormone te bepaal d.m.v. 'n porieuse boorhoudende diamantelektrode is aangetoon, en hierdie elektrodemateriaal is gepatenteer.

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*To Jesus, my closest friend,  
In all things, you do so righteously tend,  
Unlike, the billowing sand,  
Which may lead to a barren land,  
I have no fear, 'cause you have my life in the palm of your hand  
And so, in you I will forever love and trust.*

## Table of Contents

Synopsis	i
Samevatting	iii
Acknowledgments	v
Table of Contents	vii
<b>1 Introduction</b>	
1.1 Aim of investigation	4
1.2 References	5
<b>2 Manufacture of boron-doped CVD diamond</b>	
2.1 Introduction	7
2.2 Hot filament CVD and microwave plasma CVD techniques	8
2.3 Effect of varying deposition conditions on the morphology of CVD diamond	11
2.4 Effect of boron on CVD diamond	15
2.5 References	19



<b>3</b>	<b>Surface structure and chemistry of diamond and boron-doped CVD diamond</b>	
3.1	Surface structure and chemistry of diamond	20
3.2	Surface structure and chemistry of boron-doped CVD diamond	24
3.3	References	26
<b>4</b>	<b>Characterisation of boron-doped CVD diamond</b>	
4.1	Introduction	28
4.2	Scanning electron microscopy (SEM)	
4.2.1	Theory	29
4.2.2	Experimental	31
4.2.3	Results and discussion	32
4.3	Laser ablation inductively coupled plasma (LA-ICP-MS)	
4.3.1	Theory	36
4.3.2	Experimental	38
4.3.3	Results and discussion	41
4.4	Raman spectroscopy	
4.4.1	Theory	43
4.4.2	Experimental	46
4.4.3	Results and discussion	46
4.5	X-ray photoelectron spectroscopy (XPS)	
4.5.1	Theory	52

4.5.2	Experimental	53
4.5.3	Results and discussion	54
4.6	Contact angle measurements	
4.6.1	Theory	58
4.6.2	Experimental and discussion	60
4.7	Resistance measurements	
4.7.1	Experimental and discussion	62
4.8	Conclusion	65
4.9	References	65
<b>5</b>	<b>Hydrogenation and oxygenation techniques</b>	
5.1	Introduction	68
5.1.1	Hydrogen treatment	68
5.1.2	Oxygen treatment	70
5.2	Hydrogenation techniques : experimental and discussion	
5.2.1	Tube furnace treatment	71
5.2.2	Thermogravimetric analyser (TGA) treatment	73
5.2.3	Hydrogen plasma treatment	74
5.3	Oxygenation techniques : experimental and discussion	
5.3.1	Chromic acid treatment	75
5.3.2	Anodisation treatment	76
5.3.3	Thermogravimetric analyser treatment	82
5.4	Conclusion	85

5.5	References	86
<b>6</b>	<b>Electroanalysis of inorganic redox systems – potassium iron (III) cyanide and cerium (III) sulphate</b>	
6.1	Introduction	87
6.2	Experimental	89
6.3	Results and discussion	
6.3.1	Electrochemical characterisation of diamond electrodes of varying boron concentrations	92
6.3.2	Surface area effects	95
6.3.3	Potassium iron (III) cyanide	97
6.3.4	Cerium (III) sulphate	103
6.4	Conclusion	113
6.5	References	114
<b>7</b>	<b>Electroanalysis of organic systems – dopamine in the presence of ascorbic acid</b>	
7.1	Introduction	116
7.1.1	Biocompatibility studies of chemically vapour deposited diamond (CVDD)	121
7.1.2	Commercial requirements and benefits of biosensors	123
7.2	Experimental	124

7.3	Results and discussion	
7.3.1	Dopamine	125
7.3.2	Ascorbic acid	134
7.3.3	Dopamine in the presence of ascorbic acid	139
7.4	Conclusion	143
7.5	References	144

## **8 Electroanalysis of organic systems via a bio-recognition element – thyroid hormones (L-T<sub>3</sub> and L-T<sub>4</sub>)**

8.1	Introduction	147
8.1.1	Bio-recognition system	149
8.1.2	Porous diamond electrode	152
8.2	Experimental	
8.2.1	Crushing and sintering	154
8.2.2	Characterisation	155
8.2.3	Detection of thyroid hormones (L-T <sub>3</sub> and L-T <sub>4</sub> )	155
8.3	Results and discussion	
8.3.1	Characterisation of the porous BDD electrode	
8.3.1.1	Surface morphology	157
8.3.1.2	Surface chemistry	159
8.3.1.3	Electrochemical behaviour of porous BDD electrodes	161
8.3.2	Absorption kinetics	166

8.3.3	Detection of thyroid hormones (L-T <sub>3</sub> and L-T <sub>4</sub> )	
8.3.3.1	Detection of L-T <sub>4</sub>	168
8.3.3.2	Detection of L-T <sub>3</sub>	172
8.4	Conclusion	173
8.5	References	174
<b>9</b>	<b>Conclusions</b>	<b>176</b>