

1. BDD plates
2. BDD disk electrodes
3. 3-in-1 all BDD sensor
4. BDD microfabrication

BORON DOPED DIAMOND

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IN COOPERATION WITH

MICHIGAN STATE
UNIVERSITY

Overview

Boron-doped diamond is an excellent electrochemical tool with a multitude of fabrication flexibility. Its superior material properties include:

Low capacitive background current

- Improves limit of detection (LOD)
- Enables low-current analyte measurements

Application of high-current densities

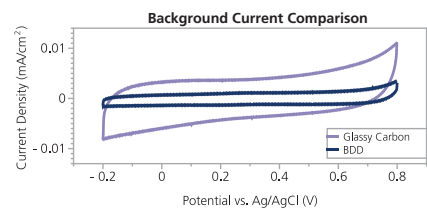
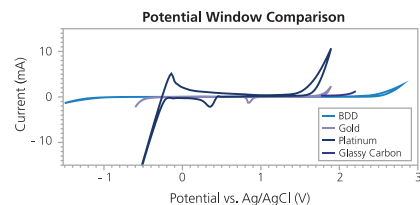
- Current densities well above 100 mA cm⁻² can be applied with no material destruction
- Efficient production of hydroxyl radicals (OH•)

High conductivity

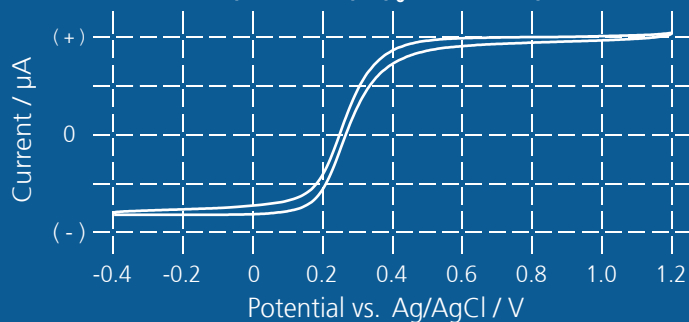
- Metal-like properties in a more robust material
- Fast electron transfer rates

Widest electrochemical window

- Measurements from -1.5 to +2.5 V are possible (even wider in non-aqueous solvents)
- Higher oxygen and hydrogen overpotentials

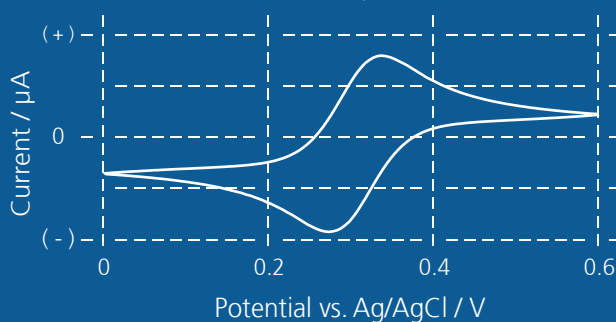


Cyclic voltammetric response of BDD MEA
(1.0 mM Fe(CN)₆ in 1.0 M KCl)



1

Cyclic voltammetry response of macro electrode
(1.0 mM Fe(CN)₆ in 1.0 M KCl)



2

Our Offer

CCD offers the development of customer specified boron-doped diamond products. For BDD electrodes, diamond is deposited onto various substrate materials and geometries. Our in-house fabrication capabilities allow material development and prototype production of complex BDD products such as framed and freestanding BDD foils. Disk electrodes, microelectrode arrays and optically transparent electrodes are fabricated for advanced electrochemical analysis.

BDD Synthesis

Boron-doped diamond films are grown by microwave plasma assisted chemical vapor deposition. Due to the large diversity of potential applications, BDD is synthesized on many substrates including silicon, quartz, pyrex and metals such as niobium, molybdenum, titanium and tungsten. The difference in thermal expansion between substrate material and diamond film at typical process temperatures of 450°C - 700°C requires carefully designed BDD growth conditions to prevent material failures induced by intrinsic residual stress. Depending on the application, BDD film thicknesses range from 100 nm to hundreds of micrometers.



3

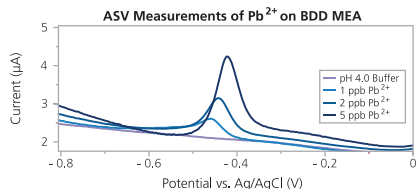
BDD Fabrication

Fraunhofer's in-house post diamond synthesis fabrication capabilities include:

- Cleanroom based microfabrication
- Metallization
- Wet chemical etching
- RIE plasma dry etching
- Polishing
- Laser cutting

BDD Analysis

- Electrochemical analysis
- Raman
- SEM
- Conductivity
- Surface roughness
- Film thickness
- XRD
- XPS
- UV/vis & FTIR



BDD Products

- BDD Disk Electrodes
- Free standing BDD plates (10x10 mm² or custom)
- Nanocrystalline (NCD), microcrystalline (MCD) and single crystalline (SCD) boron doped diamond materials
- BDD on silicon (1-8 inch in diameter or custom cut)
- BDD optically transparent electrodes
- BDD on metals (e.g. Nb, Mo, and W)
- BDD on diamond
- BDD foils (framed and free standing)
- BDD microelectrodes (Si and free standing)
- BDD microelectrode arrays (MEA)
- BDD macroelectrodes
- BDD 3-in-1 sensors (Si and flexible)

1. Cyclic voltammetry response of micro electrode array
2. Cyclic voltammetry response of macro electrode array
3. Optically Transparent Electrode