

Large Scale Diamond Electrodes for Industrial Water Treatment

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The DiaCell® Technology applicability is strongly conditioned by its treatment capacity and thus directly related to the surface of the BDD/Si electrodes. CSEM is now able to coat circular Si substrates up to 12" diameter (limited to 4" in the past), and a mosaic concept for unlimited scales was developed.

The DiaCell® technology, based on boron-doped diamond films on Silicon substrate (BDD/Si), is a new candidate in the electrochemical water treatment market. Water disinfection and also wastewater treatment and recycling are the main targeted applications^[1]. While most of the private applications such as pool water disinfection^[2] require electrode surfaces in the range of 0.1 m² per unit, the industrial water treatment applications impose to work with square meter electrode areas. The first DiaCell® concept has been developed for a small scale or prototype approach, another concept must be proposed for larger scales.

The electrode surface to be installed (m²) is defined by the volume of water to be treated per unit of time and the applicable current density i (mA/cm²). The latter is directly related to the type of treatment to be applied and the water composition. In the case of wastewater treatment, most cases concern the organic matter destruction. A simple model to determine the optimal current density for a given carbon oxygen demand (COD) was presented by Michaud^[3].

$$i \text{ (mA/cm}^2\text{)} = 0.024 \cdot \text{COD (mg O}_2\text{/l)}$$

From this model, with the initial COD of the wastewater and the target final COD, the electrode surface to be installed can be estimated (Fig. 1).

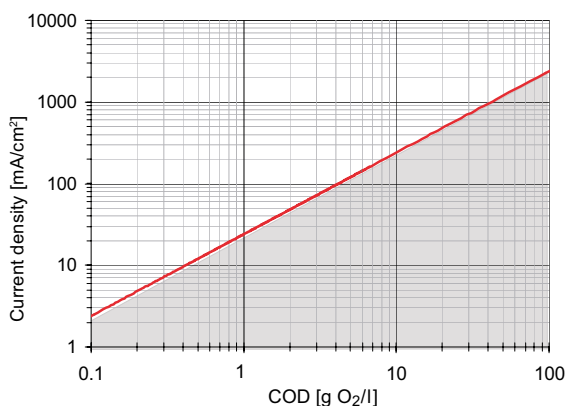


Figure 1: Definition of the electrode surface to be installed. Case of COD from 22000 ppm to 500 ppm. Definition of 40 m² anode per m³/h to be treated.

CSEM has built a new reactor to manufacture either bigger electrode surfaces, up to 0.20-0.30 m², or numerous smaller electrodes.

Circular BDD/Si electrodes are used in the specific DiaCell® electrochemical cell developed by CSEM. The original cell for 4" electrodes (70 cm²) is called DiaCell® type 100 and the new cell for 8" electrodes (280 cm²) is called DiaCell® type 200.

Each type of DiaCell® is designed with up to 5 compartments which represents 700 cm² of electrode surfaces for DiaCell® 100, and 2800 cm² of electrode surfaces for DiaCell® 200, respectively (Fig. 2).

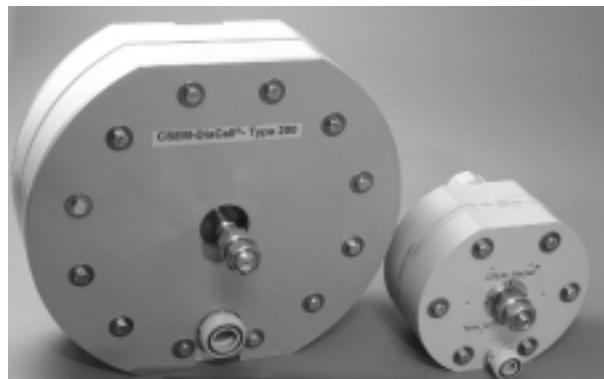


Figure 2: DiaCell® 200 (left) and DiaCell® 100 (right).

But even the electrode surfaces in the larger DiaCell® 200 are too limited to have a real impact on the industrial market. In order to go ahead with this limitation, CSEM developed a mosaic concept. The mosaic electrode consists of an assembly of many small BDD/Si electrodes joined by a specific polymer layer to protect the metallic support (stainless steel) (Fig. 3).



Figure 3: Mosaic concept - 12 BDD/Si electrodes of 6*6 cm² on 21*30 cm² stainless steel support.

All BDD/Si electrodes can be deposited on one or two faces of the metallic support to constitute a monopolar or a bipolar electrode, respectively. After assembly mosaic electrodes are integrated in a specific modular electrochemical cell called DiaMos.

The DiaCell® technology is still under development to increase robustness and reduce fabrication costs. The new mosaic concept and DiaMos will open the doors for industrial applications.

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- [1] Ph. Rychen, L. Pupunat, W. Haenni, E. Santoli, "Water Treatment Applications with BDD Electrodes and the DiaCell Concept", New Diamond and Frontier Carbon Technology - Vol. 13 (2003) 109
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- [3] P.-A. Michaud, "Comportement anodique du diamant synthétique dopé au bore", Thesis EPFL (2002)