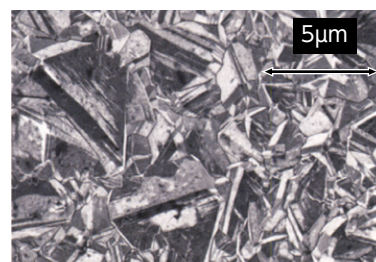


Diamond Electrode

What is a diamond electrode?

Diamond is known to be an excellent insulator. Diamonds can be made electrically conductive by boron doping, however. A semiconductor, conductor, or superconductor can be produced from boron-doped diamond by varying the concentration of the boron. A conductive diamond that has been doped to a relatively high concentration (about 10^{23} cm^{-3}) is used as an electrochemical electrode. This diamond electrode is gaining attention as a candidate next-generation electrode material that is an alternative to conventional noble metal and carbon electrodes. We expect to see such electrodes being adopted for a wide variety of applications.



SEM image of conductive diamond coating

Electrochemical characteristics

Electrolytic voltage

The theoretical decomposition voltage that is required for the electrolysis of water is about 1.2 volts (pink line in Figure 1). In fact, however, electrolysis does not proceed at this voltage. Rather, a voltage of 1.2 volts or above is required to initiate the electrolysis. The minimum voltage that is required for this electrolysis is called the "potential window." In Figure 1, the difference between potentials for the start of O_2 and H_2 evolution is equal to the potential window. The potential window depends on the electrode type.

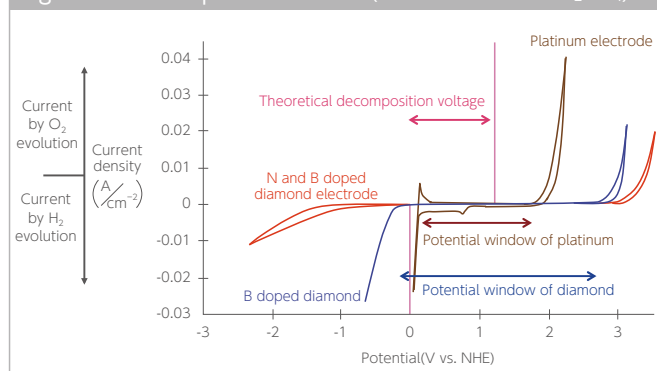
Potential window of conductive diamond electrode

The electrodes, such as titanium electrodes coated with platinum and noble metals, have a potential window of about 2 volts (brown line in Figure 1). The diamond electrode has a broader potential window of 3 to 5 volts (blue and red lines in Figure 1).

Broad potential window

A broader potential window can preferentially advance an oxidation or reduction reaction of substances that is normally hard to be electrolyzed, instead of water electrolysis reaction. The leveraging of this property enables the decomposition or synthesis of substances that were impossible with conventional electrochemical systems.

Figure 1 Current-potential curve (measured in 1M- H_2SO_4)



Applications of this electrode

01 Agriculture

Disinfection, water use, cultivation

02 Fisheries

Disinfection, water use, cultivation, sterilization, cleaning

03 Livestock farming

Disinfection, water use, cleaning

04 Food processing industry

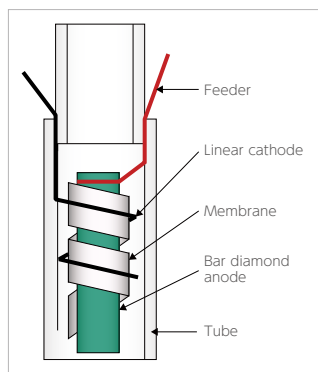
Sterilization, disinfection, cleaning

05 Medical

Sterilization, disinfection, cleaning, therapy

Practical examples

01 Synthesis of electrolyzed water by conductive diamond electrodes (DeoShower® ozonated water generator)



02 DIACHEM® conductive diamond electrode

DIACHEM® is a conductive diamond electrode that was developed by Condias of Germany. It consists of a niobium (Nb) substrate whose surface is completely covered with conductive diamond. Therefore, it can make full use of the performance of the conductive diamond.