

Microbicidal Effect of E. Coli with Ozone Solution Generated by BDD Electrode

S. G. Park, H. J. Lim, J. Y. Kim, T. Okajima*, T. Ohsaka*, A. Fujishima**

*Department of Ind, Chem. Eng. & Environmental Eng., Chungbuk National University, San 48, Gashindong, Cheongju, Chungbuk, 360-310, Korea

**Department of Electronic Chemistry, Tokyo Institute of Technology, 4259 Nagatsuda, Midoriku, Yokohama, 226-8502, Japan

***Kanagawa Academy of Science & Technology, Japan

Highly conductive boron-doped diamond (BDD) thin film has been known as an unique and attractive electrode material because of its superior properties; such as excellent hardness, physical and chemical stability and inertness, extremely high conductivity with wide range of electrochemical windows and so on. This electrode contains typical p-type semiconducting behavior with existence of boron ion in BDD electrode. Some groups have reported about characteristics of diamond single or poly-crystalline growth, but the applications of this conductive diamond materials with high physically and chemical stability against normal metal or metal oxide electrodes was rarely referred(1).

Recently, many attentions for biosensors, fuel cell electrodes and industrial applications are paid to applying conductive boron-doped diamond(BDD)electrode, which have wider potential windows(-2V<pot<+2V), low background current with low capacitance, chemical & physical stability. With chemically stable BDD electrode, we generated pure ozone gas,>18%, with high yield by electrochemical method. Also we found that microbicidal action with generated ozone by BDD shows excellent disinfection effects which shows 50% faster than chemical treatments. And this BDD shows good electrochemical response as electrodes of biosensing systems of diabetic, nicotinic detection with mixed states of ascorbic acid in human blood system.

For electrochemical measurements, we adopted self designed BDD electrode as anode in electrolysis ozone generating system with chemically stable electrode at high potential for the ozone generation,1.6V. We advanced disinfection test with changing the concentrations of generated ozone solution by BDD electrode. For the comparison of disinfection effect (ozone, H₂O and chloride), electrochemically generated ozone solution in pure water (10ppm) was used, biochemical pretreatments was used for the disinfection of Ecoli and other bacteria for 48hrs cultivation, microscope used for visible an effective insterilization of many kinds of commercial general foods such as vegetable and fruits and so on.Fig. 1 is showed the equipment of Microwave Plasma CVD (MPCVD), which used for preparation of BDD electrode with changing the concentration of boron solved methanol mixed acetone during plasma formation >18hrs. BDD and Pt electrode area are 4cm² in ozone generator system. In this system, flow rate is 40ml/min at 15V, 2A.

In this work, BDD electrode characteristics are more useful excellent than other general electrodes because of physical and chemical stability p-type semiconductor, >10⁻³ Ω•cm, wide potential window, which possible for higher potential electrolysis, inhibit hydrogen evolution reaction, and various other commercial electrochemical applications, as electrochemical ozone and medical

treatment and waste water treatment because of high powerful oxidant. Specially ozone generation by BDD showed better than PbO₂ for durability,>3X10³h

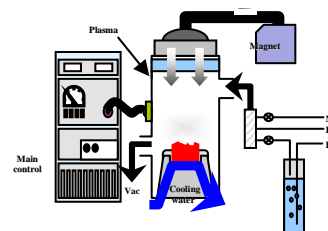


Fig. 1. Microwave plasma CVD for diamond preparation

Fig. 2 shows the disinfection effect of during 60s period treatment 2 days period cultivation. We could detect the results that the disinfection power showed ozone>chloride>water and also depened on ozone concentration. The perfect disinfection from ozone 20ppm consistency became accomplished. It was stering 95% from the chlorine and 100% from the ozone. And the disinfection concentration effect (E. coli) of 1, 10, 20 ppm ozone during 60s period treatment 1day period cultivation. The disinfection effect power depended on concentration of ozone. The perfect disinfection from ozone 20ppm consistency became accomplished. The disinfection power (celery cabbage, grapes) was sterilizing 90% from the chlorine and 100% from the ozone at during 60s period treatment 2 day period cultivation in 20 ppm ozone, water and chloride. We could get same phenomena with other foods and vegetables, which reducing bacteria and Ecoli perfectly within 1min at 20ppm ozone concentration.

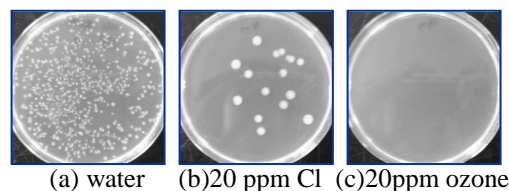


Fig.2 Disinfection effect(lettuce,perilla leaf) micals and surfactants.

Finally we could have results that electrochemically ozone was generated successful by using highly BDD electrode. And the microbicidal action of Ecoli showed that the ozone solution is superior to the other chemicals and surfactants. The disinfection power with ozone solution from the commercial vegetables and the fruits exhibit very excellent because of powerful and unharmlful oxidant. For the more microbicidal action and the sterilization effectiveness of the ozone are under discussion in many kinds of human foods and medical treatment with convenient portable ozone generator.The application is various from the next food industry comes to be expected.

This research was carried out financed by Chungbuk Dochung annual project 2004 of Korea

Reference

1. E. Popa, H. Notsu, T. Miwa, D. A. Tryk and A. Fujishima, *Electrochemical and Solid-State Letter*, 2, 49 (1999)
2. N. K. Patel. *J. Pharm. Sci.*, 53, 94 (1994)
3. H. S. Bean. *J. Pharm. Pharmacol.*, 23, 699 (1991)