

### Electrochemical Generation of Ozone Using DSA<sup>®</sup>-type PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti Electrodes

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#### Introduction

In recent years, usages of ozone (O<sub>3</sub>) in chemical industry and medical field including water treatment, deodorization and disinfection have become of much interest because of its property as a very strong oxidizing agent that does not leave harmful residues such as haloforms [1]. So far, it has been found that Pt and PbO<sub>2</sub> as the anode material show an electrocatalytic activity for electrochemical ozone production (EOP). However, Pt electrode is very expensive, and PbO<sub>2</sub> electrode is easily broken and is not good for the environment. Therefore, the development of the anode material for EOP has been needed.

On the other hand, dimensionally stable anodes (DSA<sup>®</sup>) discovered by Beer in the 1960s [2] have the outstanding properties such as high corrosion resistance and physicochemical stability under high positive applied potential which are required for anode material in chlor-alkali industry [3]. They are now widely used as oxygen or chlorine evolving anodes [4].

Here, we report EOP using DSA<sup>®</sup>-type PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti electrodes as the anode, compared to that at platinum and platinum-coated titanium (Pt/Ti) electrodes.

#### Experimental

DSA<sup>®</sup>-type PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti (size (length × width × thickness): 35 mm × 10 mm × 1 mm) electrodes were prepared by sol-gel method [5].

For electrochemical measurements including potentiostatic electrolysis, DSA<sup>®</sup>-type PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti, Pt (20 mm × 20 mm × 1 mm) and Pt/Ti (35 mm × 15 mm × 1 mm) electrodes were used as working electrode. Pt wire or Pt/Ti plate electrodes were used as auxiliary electrode. A commercially available Ag|AgCl|KCl (sat.) electrode was used as reference electrode. For galvanostatic electrolysis, DSA<sup>®</sup>-type PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti, Pt/Ti and Pt electrodes were used as anode and Pt/Ti electrode as cathode.

The electrochemical measurements, galvanostatic and potentiostatic electrolyses were performed in 0.5 M NaF aqueous solution and "standard solution" containing the components (0.025 mM KHCO<sub>3</sub>, 0.25 mM NaHCO<sub>3</sub>, 0.25 mM CaCl<sub>2</sub> and 0.25 mM MgSO<sub>4</sub>) of tap water. Ozone concentration was determined by an ozone meter (Type 46700-04, HACH Co.).

#### Results and Discussion

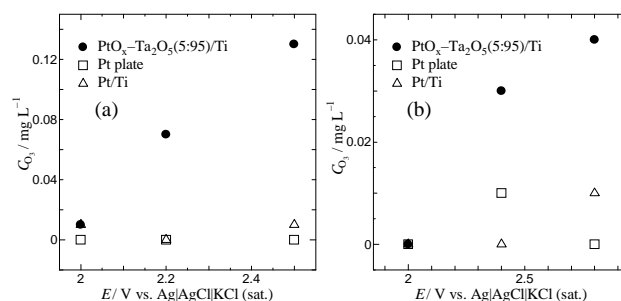
The composition of PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub> coating is considered to affect largely the electrochemical generation of ozone. So, we investigated the influence of the composition of

DSA<sup>®</sup>-type PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti electrode on EOP. PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>/Ti electrodes with the different mole ratio of Pt and Ta were used as the anode, and galvanostatic electrolysis was carried out at the current density of 16.3 mA cm<sup>-2</sup> for 1 min in the standard solution. As the mole fraction of Pt decreased, the concentration of electrogenerated ozone in the solution increased. The maximum ozone concentration was attained when the mole ratio of Pt and Ta was 5:95. Thus, it was found that PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>(5:95)/Ti electrode has the highest electrocatalytic activity for EOP.

Fig. 1 shows the typical results of the potentiostatic electrolysis using PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>(5:95)/Ti, Pt and Pt/Ti electrodes in N<sub>2</sub>-saturated (a) 0.5 M NaF and (b) standard solutions. In both solutions the highest concentrations of ozone were attained using PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>(5:95)/Ti electrode, indicating that PtO<sub>x</sub>-Ta<sub>2</sub>O<sub>5</sub>(5:95)/Ti electrode is superior to Pt and Pt/Ti electrodes as anode material for EOP.

#### References

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**Fig. 1** Plots of the concentration of ozone against electrode potential. The potentiostatic electrolyses were conducted with three kinds of working electrodes (geometrical area: 1 cm<sup>2</sup>) in N<sub>2</sub>-saturated (a) 0.5 M NaF and (b) standard solutions. Quantity of electricity passed in each electrolysis was 10 C.