グラスライニング(GL)製品の電極用途への適用
Application of Glass Lined Products for Discharge Electrode

Preface

Glass Lining (GL) products are glass-metal composites, which have traditionally been used for brewing tanks, resin polymerisation reactors and acid/alkali reaction sides due to the high corrosion resistance and adhesion resistance of glass. Glass has excellent functions in addition to corrosion resistance (chemical resistance) and is used as a stand-alone material for various lens components (translucency), semiconductor substrates (insulation and low dielectric loss), hard disk base materials, etc., in addition to beakers and other applications requiring chemical resistance. We are also developing glass lining products for various applications by adding functions other than corrosion resistance to the glass lining. This report introduces three applications that have already been commercialised and two potential applications for GL electrodes.

1 Lamps

GL electrodes are applicable to lamps that use silent discharges. 1) Quartz glass is used as an insulator, but the dielectric constant of quartz glass is as low as about 4. 1) Quartz glass is used as an insulator, but the dielectric constant of quartz glass is as low as about 4.

This paper introduces the results of joint research conducted with Doshisha University on lamps using GL electrodes.

1. 1 Structure

As this is a basic experiment, the experiment was carried out using two pipe-juku GL electrodes as shown in Fig. 2. The body of the device is made of ceramics, and the mounting angles of the end faces at both ends of the body can be changed. The electrode base material is made of stainless steel in order to allow cooling water to flow through it.

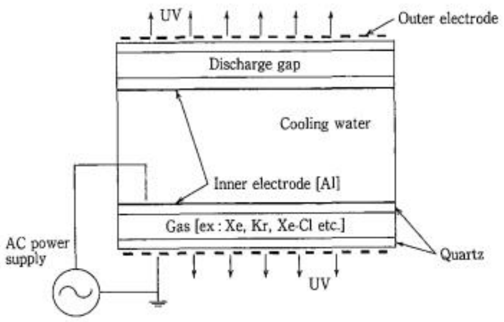
1.2 Experimental results

1.2.1 Emission wavelengths and spectra

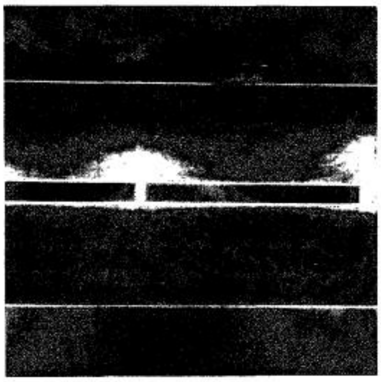
Figure 3 shows the emission spectra when Xe, Ar and Kr are used as the inclusion gases. Even when a GL electrode is used, different wavelengths of light can be obtained by changing the inclusion gas in this way. 2) By selecting the inclusion gas, it is possible to obtain light ranging from vacuum UV to visible light. 3)

1.2.2 Gas pressure and dose

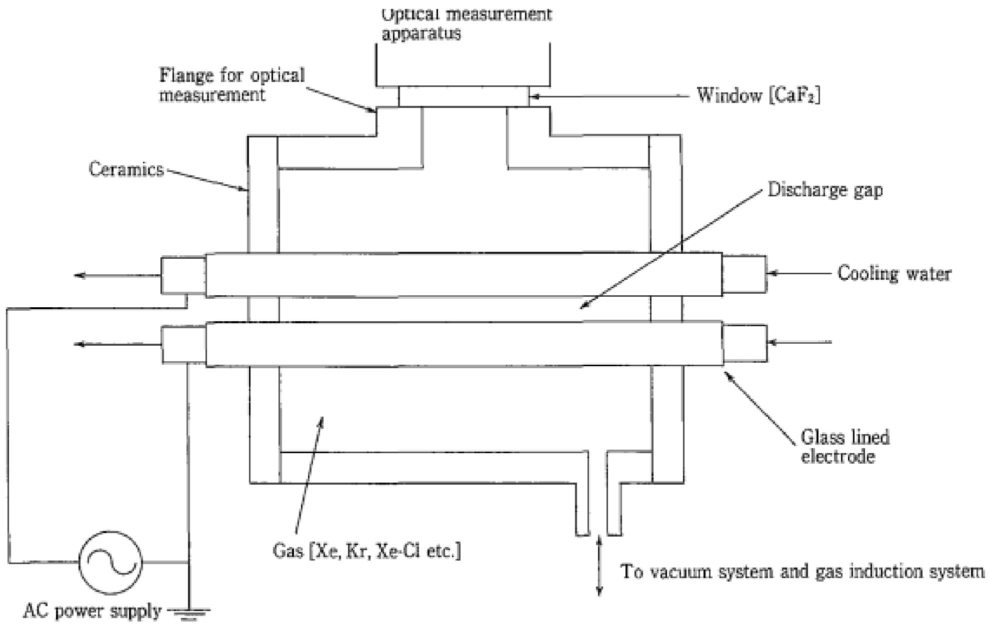
Figure 4 shows the relationship between the enclosed gas pressure and the light output obtained when Xe and Cl mixed gases were used. An AC voltage of 6 kHz and 7 kV was applied. The maximum value for the Xe and Cl mixed gas is around 160 torr. The same was true for the I(r and Cl mixed gas. However, in the case of Xe alone, the light output increased with gas pressure.



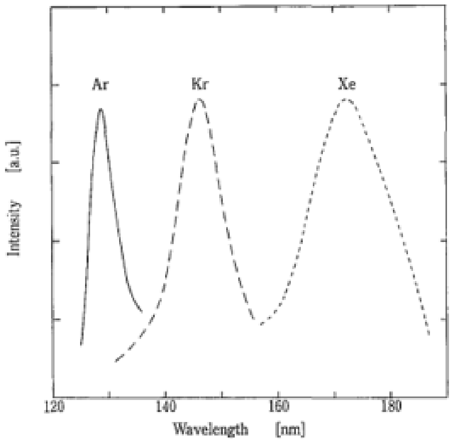
第 1 図　エキシマランプ構造模式図
Fig. 1　Schematic illustration of eximer lamp



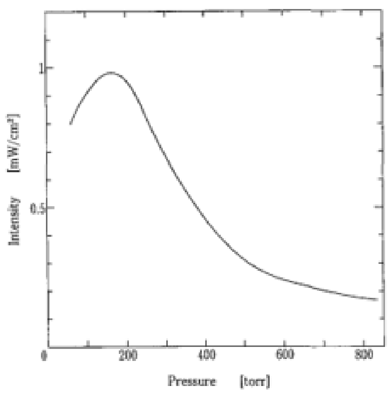
写 真 1　放電中のGL電極部（Xeガス 1. 1気圧）
Photo.1　Appearance of discharge at GL electrodes (Xe gas at 1. 1atm)



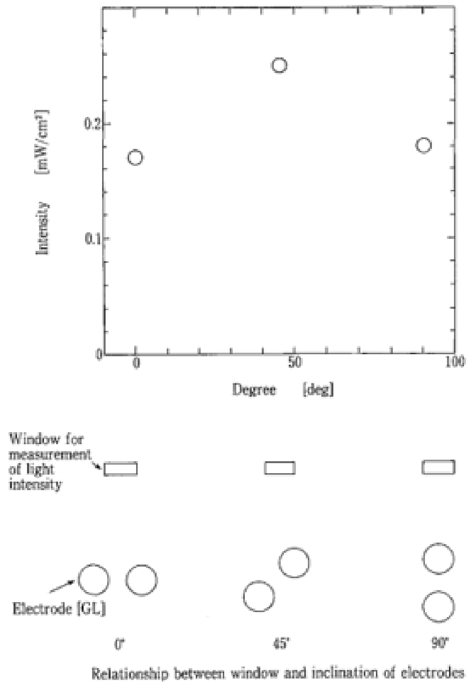
第 2 図　実験用リアクター構造模式図
Fig. 2　Schematic illustration of experimental reactor



第 3 図 Ar,Kr,Xeを使用した場合の発光スペクトル
Fig. 3 Spectrum of UV source about Ar, Kr, Xe



第 4 図 ガス圧力と光出力の関係（0.22%塩素含有Xeガス使用）
Fig. 4 Relationship between gas pressure and UV intensity (Gas : Xe contents 0.22% Cl_2)



第 5 図 電極角度と光出力の関係
Fig. 5 Relationship between inclination of electrodes and UV intensity

1. 2. 3 Dose distribution around the electrodes

In this experimental apparatus, two pipe electrodes are arranged in parallel to generate a discharge, in which case the distribution of light output around the electrodes may differ greatly. For example, when pipe electrodes are arranged in parallel and irradiated in a quotient shape, the stronger 45° direction is more suitable for average irradiation.

1.3 Future developments

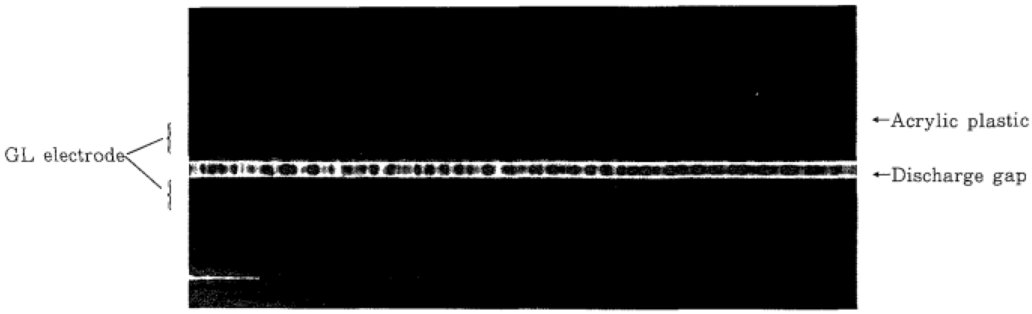
The data presented here do not allow for an examination of the efficiency of using glass with a large dielectric constant (approximately twice that of quartz glass), but even taking into account the increase in reactive power due to the increase in dielectric loss, the increase in discharge power due to the doubling of the dielectric constant is expected to be greater, The electrode structure used in this study is two pipe-shaped electrodes arranged in parallel, but with GL electrodes, depending on the electrode structure, it is possible to install both a ground electrode and a high-voltage electrode in one electrode, so it is possible to generate a discharge and emit light with a single pipe-shaped GL electrode, for example, which provides flexibility in structure. We hope that the university will continue experiments in consideration of the aforementioned features of GL, and that GL lamps with features different from existing products will be commercialised, leading to the development of new GL products.。

2. Ozonisers

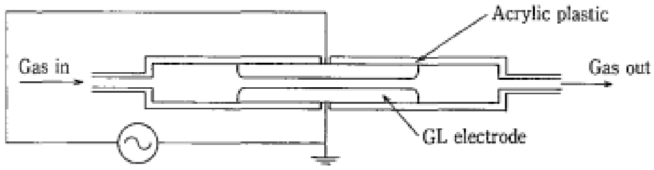
Ozonisers are usually made by inserting a glass tube with a conductive film coated on the inner surface into a stainless steel pipe and generating an electrical discharge between the voids to produce ozone, while GL ozonisers are made by inserting a stainless steel pipe into an inner GL pipe and generating a discharge in the same manner.4) Ordinary The Company has developed a glass for discharge electrodes with a dielectric constant approximately twice that of ordinary GL glass. The results of an experiment comparing the ozone concentration generated by using this glass and normal glass for lining are presented.

2. 1 Experimental apparatus

A sample lined with normal underlining glass and overlining glass on mild steel and a test piece in which the overlining glass was changed to high dielectric constant glass are shown. A schematic diagram of the experimental ozoniser is shown in Fig. 6 and a photograph of the electrode space during discharge is shown in Photo 2.



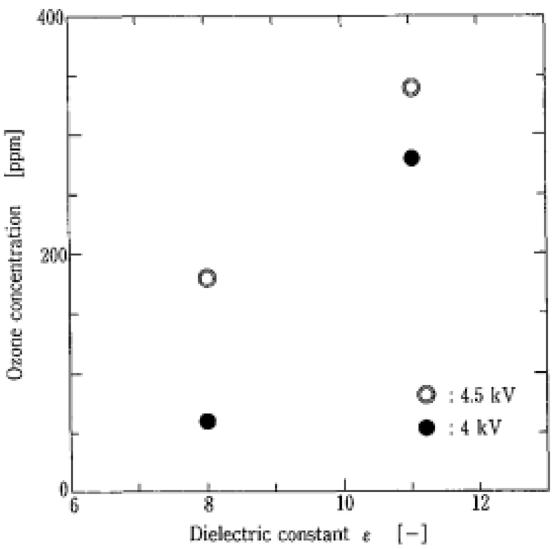
写 真 2　G L電極間での放電（大気中）
Photo.2　Appearance of discharge between GL electrodes (Atmosphere : Air)



第 6 図　ＧＬ電極を使用したオゾナイザーの模式図
Fig. 6　Schematic illustration of ozonizer with GL electrodes.

2.2 Experimental results

In the experiment, room temperature air was fed at 20 e/min by an air pump and a high voltage of 5 kHz was applied at a gap of 1 mm between the electrodes to generate a discharge between the electrodes to produce ozone, and the ozone concentration at the outlet was measured. As might be expected, the higher the dielectric constant, the higher the ozone concentration obtained. Although only a very simple experiment was carried out, it was found that the high dielectric constant glass tended to have a lower discharge starting voltage than the glass lined with the high dielectric constant glass. This may be due to differences in glass composition.



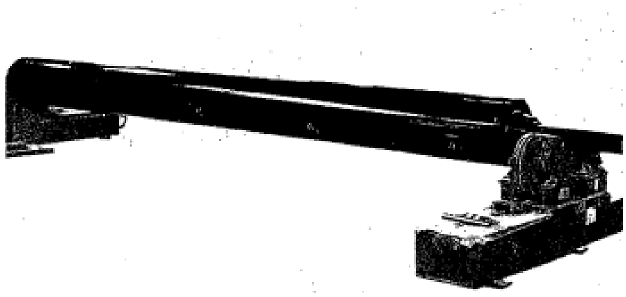
第 7 図　発生オゾン濃度と誘電率の関係
Fig. 7　Relationship between ozone concentration and dielectric constant at 4kV and 4.5kV

2.3 Future developments

The superiority of high dielectric constant glass was evaluated in a simple experiment this time, and next, ozone generation experiments will be conducted on the lining of high dielectric constant glass alone to evaluate the ozonisation efficiency and clarify the performance of high dielectric constant glass. We intend to conduct experiments in various applications in the future and evaluate them.

The glass lined rolls are used as a coating material for conventional products, which have problems in terms of surface hardness, heat resistance and ozone resistance. Photograph 3 shows a Treater mouthpiece made of glass lining.

3. treater rolls,



写 真 3 トリーターロールの外観
Photo.3 Appearance of treater roll

3.1 Excellent heat and ozone resistance

Glass for glass linings is used in the chemical industry in high-temperature corrosive atmospheres and has excellent thermal shock resistance. In corona discharges, there is a temperature rise due to the discharge, which can cause burning (melting) problems with resins and rubbers, etc. However, glass can be used in high-temperature corrosive environments. However, due to its excellent heat resistance, even if the rolls stop rotating for some reason, problems such as glass melting do not occur for several tens of minutes. glass is stable against most chemicals except futric acid and strong alkalis. ozone is generated from oxygen in the air by the discharge in the case of corona discharges. In addition, when adhesions occur on the roll surface, resin and rubber rolls are difficult to remove (mechanical strength, solvent resistance and acid resistance are weak), but glass can be cleaned with solvents and acids.

3.2 Electrical characteristics

In the case of treater rolls, the glass thickness is 1.5 mm and has a high withstand voltage strength of 40 kV/mm. The dielectric constant is as high as 8, which enables sufficient processing at a lower output compared to resin or rubber rolls. The glass used for the treater rolls is designed so that there is almost no change in dielectric constant even when used at high temperatures, thus ensuring stable processing.

3.3 Economy

Treat rolls are more expensive than resin or rubber rolls, but they are economical considering that the life of a treat roll is several times longer (several years) than that of resin or rubber rolls, and that they are easy to maintain and have excellent electrical performance.

4. pH electrode

To measure pH in a reaction tank, an ordinary glass membrane electrode with a protective tube is installed in the reactor, but damage and contamination due to pressure fluctuations can be a problem. The glass-lined pH sensor6) sold by this company has excellent mechanical strength because it is lined with a highly corrosion-resistant measuring electrode glass on a base metal, and can be installed directly in reaction vessels containing high-speed fluids or liquids with high viscosity or solids.

4.1 Structure

Figure 8 shows a schematic diagram of the pH sensor structure. pB glass is lined on top of a silver conductor which is coated on the GL surface. The potential generated on the pH glass is extracted externally by a conductor embedded in the lining glass layer, which is yoked to the silver conductor. This makes it difficult for measurement errors to occur due to blockage, etc. at the diaphragm.

4.2 Performance

1) The sensor can guarantee 55 mV/pH (at 25 ° C) or more compared to the theoretical emf characteristic value of 59.15 mV/pIII (at 25 ° C), which is comparable to the pH meter (glass membrane electrode) of commonly used scientific instruments. pH range with linearity in emf characteristic is pH 0-10, and at pHIO The temperature change is also at the same level as that of glass membrane electrodes, but a temperature measuring element is installed inside the sensor to enable automatic compensation.

2) Corrosion resistance The corrosion resistance of pli glass is inferior to that of glass for normal chemical machinery, so the life of the sensor is determined by the corrosion resistance of the pH glass.

3) Transverse mechanical strength The mechanical strength is as high as that of ordinary

baffles, etc., because of the glass lining.
4) Ripening properties Due to freezing and boiling of the internal liquid, the normal operating temperature range is 0 - 140 ° C. Ripening impact properties are acceptable down to -T-130 ° C as with our standard glass.
5) Responsiveness
90% response time to a sudden change in pH from pHO to pHIO is within about 3 seconds, even the final value is indicated in 5-60 seconds.

4.3 Future developments
In addition to pH sensors, we currently sell temperature sensors, level sensors and alarm sensors, and in the future we hope to commercialise sensors that can measure ion concentrations other than pH (hydrogen ion concentration skin).

5. Discharge electrodes
Our
GL electrodes have been adopted for equipment that generates glow and silent discharges in an inert gas atmosphere and uses a small amount of reactive gas, which is included for surface treatment together with the inert gas, to perform surface treatment of the treated product.
Reasons for adoption.

(i) Coolable barrel construction.
Cooling is essential as temperature rise occurs due to discharge.
(ii) Good glow discharge stability.
If many spark-like discharges occur instead of glow discharges, the treated products may be damaged, so glow discharge stability is required.

(iii) High discharge output.
Good glow discharge stability and high discharge output can be obtained.
Normally materials with good glow discharge stability have a small dielectric constant and cannot produce a large discharge output.

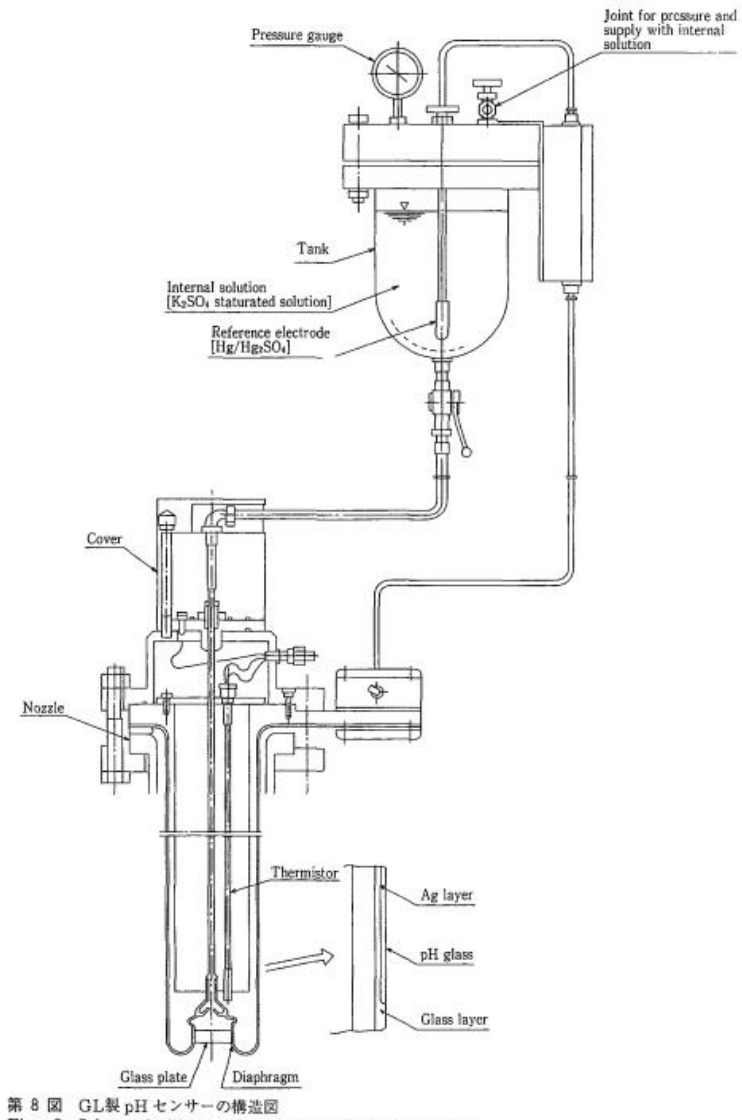
(iv) Good surface smoothness
The surface of the GL electrode is a glass surface and is very smooth. Therefore, it will not be scratched even if the product to be treated comes into contact with it.

(5) High mechanical strength

The GL electrode has very high mechanical strength due to the fusion of the glass and base metal, which makes it easy to handle when attaching and detaching the equipment.

This equipment requires all the good points of the GL electrode as described at the beginning, and our GL electrode has been adopted because it meets all these requirements.

The most important point of this electrode was to maintain high discharge output while maintaining glow discharge stability, which was solved by our long-standing GL manufacturing know-how and glass composition design.



第 8 図 GL製 pH センサーの構造図
Fig. 8 Schematic illustration of structure of pH sensor

postscript

In this report, we have introduced experimental examples and application examples (products) of GL electrodes. In our technical research institute, we also develop prototypes individually for each user to meet their needs for various applications. We will continue our efforts to develop GL products that utilise the excellent characteristics of glass, and will also continue to develop products that meet the needs of individual users. We will continue our efforts to develop GL products that utilise the excellent characteristics of glass, and also continue to develop products that meet the needs of individual users in detail.