

10 from finely pulverised natural rock crystal.

In order to produce a high density of circuits, silicon single crystals of higher must be manufactured in the semiconductor. The quality of silicon single crystals is  
15 affected by impurities, for example, alkal such as Na, K and Li, and copper.

#### SUMMARY OF THE INVENTION

The object of the present invention is to an electrolysis apparatus which can efficiently  
20 impurities from a vitreous silica or silica component.

According to the present invention, an electrolysis apparatus comprises a furnace for setting a component made of silica glass or vitreous

applying a voltage across the component placed b  
the anode and the cathode.

inert gas to a space between the anode and/  
and the holding tube.

It is preferable that the anode is  
by the holding tube in such a manner that  
15 gas can flow through a space between the  
the holding tube. A DC power source is co  
the anode and the cathode.

Preferably, a silica glass component  
between a cathode plate and an anode plate

furnace is heated at 1,000°C or above by the  
Also, the inert gas is supplied at a prescribed  
rate into space between the anode and the holder  
from the inert gas supply means so as to ensure  
15 ion between the anode and the holding tube.

The impurities such as alkali metals and  
contained in the silica glass component are  
toward the cathode.

Preferably, a predetermined amount of quartz  
20 powder is placed between the component and the  
plate. Also, a predetermined amount of carbon  
is placed between the component and the anode.  
It is not necessary to change the shape of the  
anode and/or cathode even if a silica glass component  
25 a complex shape like a crucible. In such a

ent. The electrolysis of the silica glass shifts metallic impurities such as alkali and copper contained in the silica glass component to the unmelted part at the cathode plate so that the impurities can be trapped by the unmelted part. During electrolysis, the unmelted part is removed by the cathode or the like.

A cathode is preferably placed in a holder so that an inert gas can be supplied at a predetermined flow rate into a space between the holding member and the cathode from an inert gas supply means.

According to the present invention, metallic impurities can be effectively removed from a silica glass component by electrolysis.

containing more than 20 wt% of  $\text{SiO}_2$ , the br  
alkali metals therein and prevent alkali met  
entering the inside space of the furnace. 2  
vitrification of the silica glass component  
15 prevented from being electrolysed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig 1 is a schematic view showing an ele  
apparatus according to an embodiment of the  
invention;

20 Fig 2 is a schematic view showing an ele  
apparatus according to a further embodiment  
present invention; and

Fig 3 is a schematic view showing an ele  
apparatus according to still another embod  
25 the present invention.

16 placed between the electrode plates  
upper and lower ends of the heaters 2, 3 extend  
from the furnace 1 in a vertical direction.  
connected to a temperature control means  
15 be conventional.

A temperature measuring means 5 is  
the furnace 1 so as to measure temperature of a  
determined portion of the furnace 1. And  
the temperature measuring means 5 includes  
20 ion a thermocouple 6 and a protective tube  
silicon carbide. The protective tube 7  
is in the furnace 1 so as to cover the thermocouple.  
The upper end of the protecting tube 7 projects  
from the top of the furnace 1. The lower  
25 protecting tube 7 reaches the bottom of

10 if the thermocouple 6 is not protected by the  
tube 7 in the furnace 1. In other words, it  
induce discharge in a high-temperature, high  
atmosphere of the furnace 1.

The anode 8 and the cathode 9 are made of  
15 They are arranged coaxially in a vertical direction.  
The anode 8 is joined to the anode plate 10. The  
cathode 9 is joined to the cathode plate 11. The  
plates 10, 11 are parallel to each other in a horizontal  
position. The silica glass component 16 can be held  
20 them. In other words, as best shown in Figure 1,  
the anode plate 10 is in contact with the upper end of  
the silica glass component 16 while the cathode plate  
11 is in contact with the lower end of the silica  
component 16.

means 14 into the gas blowing tube 13. The  
supply means 14 contains a predetermined  
inert gas such as nitrogen gas. An exam  
controlling means 14a is a flowmeter. Th  
15 can be fed at a flow rate of 10 to 15 mm/sec.

The anode 8 and the cathode 9 are c  
a DC power source 15 having a capacity c  
200mA.

An example of the silica glass c  
20 is a process tube.

In operation, the component 16 is pla  
the anode plate 10 and the cathode plate  
heated at 1,000°C or above by the heaters  
furnace 1. Also, a DC voltage of 1 to 10kV  
25 for 3 hours or more across the electrode

10

During the above-mentioned operation, the gas is continuously supplied at a flow rate of 15 mm/sec via the gas blowing tube 13 and the tube 12 into the furnace 1 along the anode. The inert gas not only cools the holding tube 12 to be maintained at about 400°C but also ensures insulation between the holding tube 12 and the anode 8 so as to obtain an insulation resistance of  $10^8$  ohm cm.

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If the flow rate of the inert gas is lowered to 10 mm/sec, the holding tube 12 is likely to be insufficiently cooled and the insulation of the tube 12 may be poor. If the flow rate is increased to 15 mm/sec, the anode 8 and the upper part of the element 16 are cooled too much, which decreases the

electrolysis, any discharge does not take the lower end of the thermocouple 6 because couple 6 is protected by the protecting tube

Fig 2 shows a further embodiment of invention. The structure of an electrolysis shown in Fig 2 is substantially the same as in Fig 1 except insulation materials 20, Therefore, the like reference characters like or corresponding parts. They are not

In Fig 2, the furnace 1 has the insulation materials 20, 30 and 31. The insulation material is fixed to the insulation material 20. The material 31 is attached to the bottom of 1 such that they surround the component 16. The insulation material 20 is made of fiber glass or

on account of  $\text{SiO}_2$  contained therein. Therefore, prevent the furnace 1 from being contaminated by the alkali metals, and the component 16 may be protected from devitrification.

15            On the other hand, in Figs 1 and 2, a predetermined amount of glass powder such as quartz glass can be interposed between the lower end of the component 16 and the cathode plate 11 prior to electroplating the shape of a layer having a thickness of p-  
20   5 to 20 mm. If the layer is thinner than 5 mm, the cathode-side portion of the component may be devitrified. Conversely, if the layer is thicker than 20 mm, it may have an excessively high electric resistance which prolongs the time required for electroplating.

invention. A component 46 is made of s  
or vitreous silica in a crucible shape.  
material is finely grained powder produced f  
rock crystals. A preferred powder has a  
15 particle diameter of 100 to 200 microns.  
powder is subject to a deironation treatment,  
is purified by floatation and then further  
by dipping in 10 % hydrofluoric acid at 50  
for 20 hours. The purified powder is sha  
20 crucible by a rotary melting method. Th  
46 is set in position between a pair of elect  
40, 41 which are joined to an anode 48 and  
49, respectively. The electrode plate  
while the other electrode plate 40 is for  
25 shape of a crucible as a core. A spiral or

the anode is slightly raised through and is  
a bottom portion of the anode plate 40. The  
49 is joined to the cathode plate 41. The anode  
40 is placed inside of the component 46. The  
between the anode plate 40 and the component  
15 filled with carbon powder 50 having an average  
size of 5 to 40 microns. A cylindrical main  
and a disk-shaped bottom die 52 are made of  
or silicon carbide and set on a bottom portion  
furnace 1 in the shape of a cup. The component  
20 is positioned inside the main die 51 in such  
that the space between the dies 51, 52 and the component  
46 is filled with quartz glass powder 53. The  
plate 41 is placed between the bottom die 52  
bottom portion of the furnace 1 under the component  
25 46 in such a way that the cathode plate 41

positioned between the anode plate 40 and  
plate 41 is heated at 1,200°C by the heater  
furnace 1 while a DC voltage of 1.5 KV is ap  
the component between the electrodes 48,  
15 minutes or more so as to carry out elec  
the component 46, thereby shifting the  
contained in the component 46 toward the quart  
53 until the impurities can be sufficien  
thereby.

20 During the operation, the inert gas  
uously supplied in the above-stated manner.

The present invention is not limited to  
mentioned embodiments. The silica glas  
16 is not limited to a crucible or a pr  
25 The temperature measuring means may be



so that the component can be electrolysed in  
furnace, the heater being an additional heater providing  
heat in addition to any heating effect provided by  
applying a voltage across the component placed  
15 the anode and the cathode.

2. An electrolysis apparatus as claimed in  
Claim 1, further comprising a protecting tube adjacent  
to the furnace and a thermocouple inserted in the  
protecting tube for measuring temperatures in the  
20 furnace.

3. An electrolysis apparatus as claimed in  
Claim 1, wherein the anode is joined to an anode plate  
and the cathode is joined to a cathode plate and wherein  
the component is held in position between the cathode  
25 plate and the anode plate for the electrolysis process.



Claim 6, further comprising a die means made  
or silicon carbide, the die means being con  
the cathode plate, the anode plate being pla  
the die means.

15           8.     An electrolysis apparatus as c  
Claim 1, wherein the holding means includes  
tube attached to the furnace for holding t

          9.     An electrolysis apparatus as c  
Claim 1, further comprising means for sup  
inert gas into a space between the anode and t  
20     means.

          10.    An electrolysis apparatus as c  
Claim 9, further comprising means for cont  
flow rate of the inert gas to be supplied.



14. An electrolysis apparatus as cl  
Claim 3, wherein glass powder is interposed  
the component and the cathode plate.

15. An electrolysis apparatus as cl  
15 Claim 14, wherein the glass powder constitutes  
having a thickness of 5 to 20 mm.

16. An electrolysis apparatus as cl  
Claim 1, wherein the anode and the cathode  
of carbon.

20 17. An electrolysis apparatus as cl  
Claim 1, wherein the holding means includes a  
tube in which the cathode extends in such  
that the cathode is supported by the holdi

18. An electrolysis apparatus as cl  
25 Claim 1, wherein the holding means includes a



