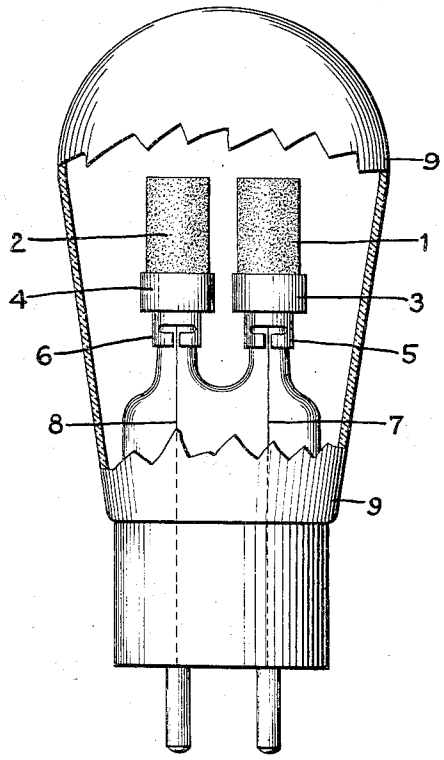
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ELECTRICAL DISCHARGE DEVICE AND ELECTRODE THEREFOR

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ELECTRICAL DISCHARGE DEVICE AND ELECTRODE THEREFOR

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This invention relates to electrical discharge devices and specifically to cathodes or electrode elements for ionic discharge devices.

An object of the invention is to provide a cathode for an ionic discharge device, capable of operation with a low work function.

Another object is to provide a cathode that enables the operation of an ionic or glow discharge device without heating of electrodes; further to allow such operation at a low potential so that commercial glow lamps operable with a long life can be made for commercial line voltages such as 110 volts.

A further object is to provide a cathode for ionic discharge devices which can be uniformly produced at low cost.

Still another object is to provide a cathode for ionic discharge devices capable of maintaining its low work function over a long life period.

A further object is to provide a cathode for an ionic discharge device having a low sputtering rate.

Another object is to provide a cathode having on its surface an integrally formed low work function layer.

Further objects will be apparent from the disclosure and from the drawing which shows a glow lamp utilizing electrodes made according to the methods herein described.

The improved electrode of my invention comprises a base of an alkaline metal silicide, such as calcium or magnesium silicide which has been formed into shape and has a low work function layer integrally formed on its surface by the reduction of an alkaline metal compound reducible by the silicide.

I have found that an electrode composed of pressed and sintered calcium silicide granules can be heated in an evacuated atmosphere to about 1400° C. without being decomposed. I have also found that if this electrode is coated with a mixture of strontium or barium carbonates, the latter will be reduced to oxide when the electrode is heated. Due to the rough surface of the silicide electrode, the oxide is firmly held. I have further found that by heating the oxide coated electrode to a temperature between 1400° C. and 1600° C., the oxide is reduced in part to the metal, for instance barium, and the layer formed has a very low work function. This action will continue to some extent during the life of the device by virtue of the bombardment loss of the electrode. At the high temperature, part of the calcium silicide will also be reduced to calcium.

Preferably, the heating of the electrode is accomplished inductively by the common form of induction heater used in the radio art.

By regulating the temperature of the electrodes the amount of sputtering during the heating process can be minimized to a negligible amount and only sufficient reduction for activation is necessary. Activation can be accomplished also by applying a high frequency discharge to the electrode so that ionic bombardment occurs.

While calcium silicide is described and has some advantages such as its high decomposition temperature, I have also used magnesium silicide which operates in the same manner, but will dissociate at a lower temperature. Magnesium silicide is of advantage where the oxide used requires a lower reduction temperature and might volatilize at the temperature required for dissociation of the silicides.

Also, for some purposes, other alkaline metal silicides could be used, such as strontium or barium silicide, but in general I have found it best to have the base composed of a silicide of the second periodic group of alkaline earth metals.

In order to describe in detail a method of manufacturing the embodiment of this invention, reference is now made to the drawing:

Electrodes (1) and (2) are made by pressing calcium silicide granules into rods and sintering them in an inert atmosphere into a hard mass. These are sprayed with a mixture of strontium and barium carbonates, using a 5% butyl acetate solution as a binder. If desired, a small percentage of alkaline earth oxide can be added to the silicide prior to pressing, this being of advantage where high current densities are had.

The electrodes are held in cups (3) and (4), which are supported by ferrules (5) and (6) connected to the glass press. Connection of the electrodes to the external voltage supply is made through leads (7) and (8). The assembly is mounted within bulb (9).

The bulb is mounted on the vacuum pump and baked to eliminate water vapor, the electrodes and other parts being heated to a high temperature. At about 1200° C. all of the carbonate is dissociated into oxide, the CO_2 being withdrawn by pumps. The device is then filled with a low pressure atmosphere of neon or mixture of neon with other low ionization potential gases or vapors such as argon, helium, krypton or mercury vapor. The pressure is usually in the order of 50 mm. of Hg. After the gas is admitted the device is sealed off the pump manifold and the electrodes are heated by discharging a current be-

tween them which activates the surface by locally heating the electrode in minute areas to temperatures of about 1500° C., when a reduction of the silicide is noted with the formation of a mixture of barium, strontium and oxides of barium and strontium. Calcium oxide and calcium are also produced, due to reduction, the calcium oxide formed on the surface assisting as a binding medium. The integrally formed low work function layer of the cathode is an important feature of the invention and offers considerable advantage over loose or non-integral coatings.

The electrodes can also be heated by induction to the reduction temperature, and any barium metal evaporated can be recondensed on the electrode surface.

The device will start at a low voltage, such as 50 volts A. C. and will have a useful life on a 110 volt circuit.

While I have described the electrode for use as a commercial glow lamp it can be used for many other devices where a cold discharge having a low work function electrode is desired, such, for example, as rectifiers, in which case only one of the two electrodes would be of the type described; or a relay device in which a grid control electrode would be used to control the discharge from the silicide cathode surface to a cooperating anode.

In addition to the formation of the surface layer by the reduction of the strontium and barium compounds, a surface layer of low work function may be obtained through reduction of compounds of caesium, rubidium, sodium or potassium by the silicide, for instance by the employment of carbonates or oxides of these metals.

For photocells I may use a silicide such as magnesium silicide having a reduced coating of caesium or rubidium.

Since certain changes in carrying out the construction of the discharge device and its electrodes, and obvious substitutions can be made in the arrangement of the elements and in the materials without departing from the scope of invention it is intended that all matters contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limited sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A low work function electrode for ionic discharge devices composed substantially of calcium silicide.

2. A low work function electrode for ionic discharge devices composed substantially of magnesium silicide.

3. An electrode for ionic discharge devices composed of a silicide of the second periodic group of alkaline earth metals and having a coating formed from a salt compound of at least one of the elements strontium, barium, calcium, caesium, rubidium, sodium and potassium reducible to the oxide thereof.

4. An electrode for ionic discharge devices comprising an alkaline metal silicide having a coating of an alkaline earth oxide.

5. An electrode for ionic discharge devices composed substantially of calcium silicide having a coating of a low work function material.

6. An electrode for ionic discharge devices composed substantially of calcium silicide having a coating of an alkaline earth oxide.

7. An electrode for ionic discharge devices composed substantially of magnesium silicide having a coating of a low work function material.

8. An electrode for ionic discharge devices composed substantially of magnesium silicide having a coating of an alkaline earth oxide.

9. An electrode for ionic discharge devices comprising a base of an alkaline metal silicide having on its surface small amounts of at least one of the elements strontium, barium, calcium, caesium, rubidium, sodium and potassium.

10. The method of making electrodes for ionic discharge devices which comprises forming the electrode base from an alkaline metal silicide, coating said base with a reducible compound of one of the elements strontium and barium and heating said electrode to a temperature sufficient to partly react said coating with said base.

11. The method of making electrodes for ionic discharge devices which comprises forming the electrode base from a silicide of one of the metals calcium and magnesium, coating said base with a reducible compound of one of the elements strontium and barium and heating said electrode to a temperature sufficient to partly react said coating with said base.

12. The method of making cathodes for ionic discharge devices which comprises forming the cathode base from granules of one of the compounds magnesium silicide and calcium silicide, sintering said base, coating said base with at least one of the compounds strontium carbonate and barium carbonate, and heating said electrode to a temperature sufficient to partly react said coating with said base.

13. An ionic discharge device having a plurality of electrodes, at least one of which substantially consists of a low work function material of the class comprising magnesium silicide and calcium silicide so as to permit operation of said ionic discharge device at low voltages.

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