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ASYMMETRICAL CONDUCTING DEVICE

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This invention relates to the manufacture of devices that offer a greater resistance to current flow in one direction than in a reverse direction therethrough, and, more particularly, to such devices of the copper-cuprous oxide type.

An object of this invention is to improve the method of manufacture of copper-cuprous oxide rectifiers.

A feature of this invention comprises heat treating a copper body or blank at a temperature above that at which cupric oxide will form in order to form cuprous oxide thereon.

Another feature comprises placing such a heat treated body while at the elevated temperature in an atmosphere inert to the treated body and allowing it to cool to a lower temperature.

Still another feature comprises such an inert atmosphere of a molten inorganic salt or salt mixture, a molten metal, or an inert gas.

A further feature comprises moving the treated body in and out of molten salt until the body is entirely coated with salt.

Still another feature comprises placing the treated body in a bath of molten sodium chloride at a temperature of about 800° C.

Other and further features of this invention will be obtained from the detailed description which follows hereinafter.

Heretofore, it has been the practice in manufacturing copper-cuprous oxide rectifiers to heat treat the copper body in an oxidizing atmosphere at about 1000° C. in order to form cuprous or red oxide thereon. At this temperature, however, cupric or black oxide forms. Since the cupric oxide increases the resistance to current flow in each direction, and lowers the rectification ratio, it either must be removed by mechanical or chemical means, or it must be reduced to copper to form a thin film on the cuprous oxide.

In accordance with this invention, the copper body, disc, or member is heat treated in an oxidizing atmosphere at a temperature above that at which cupric oxide forms so that cuprous oxide only will be formed. Cupric oxide will form at below about 1020°; the heat treatment, therefore, is at above 1020° and preferably at about 1030° C.

After the heat treatment and the formation of the desired layer of cuprous oxide, the treated copper body at its elevated temperature is placed in a bath of molten material, preferably an inorganic salt, a mixture of inorganic salts, or a metal having a low melting point.

Salts that have been found satisfactory include sodium chloride at about 800° C.; a mixture of

sodium chloride and lithium chloride at about 500° C. to 600° C.; a mixture of potassium chloride and lithium chloride at about 500° C. to 600° C.; and a mixture of sodium chloride, lithium chloride and potassium chloride at about 500° C. to 600° C. Metals that have been found satisfactory include lead and tin, maintained at a temperature of about 500° C.

It is preferred, however, to use a molten sodium chloride bath maintained at about 800° C. The treated copper body is moved in and out of this bath until it is coated with salt. Its heat treatment, thereafter, is determined by the characteristics which it is desired that copper-cuprous oxide body shall have. It is preferred, however, to place the salt coated copper body in a furnace or suitable atmosphere maintained at a temperature of about 500° C. to 600° C., and, after the body has cooled down to about that temperature, cooling it quickly to about room temperature by quenching it, for instance, in cold water. The salt coating may then be removed, leaving a copper body having an oxide coating of cuprous oxide only thereon.

When either a molten salt or molten metal bath at about 500° C. to 600° C. is employed, the treated copper body is allowed to remain therein until it has reached that temperature, and, thereafter, preferably, is cooled quickly to about room temperature by quenching, for instance, in cold water.

Instead of transferring the heat treated copper body at its elevated temperature to a molten salt or molten metal bath, it may be placed in an oxygen-free atmosphere, and allowed to cool to the desired lower temperature. Such an atmosphere could be of an inert gas, such as helium or argon, or such a gas as nitrogen. As the treated body cools, formation of cupric oxide will be inhibited.

Of course, the copper body may be subjected to the oxidizing treatment at a temperature below 1020° C. Black or cupric oxide will form on the outer surface of the red or cuprous oxide. Thereafter, the treated body may be placed in a suitable atmosphere at a temperature above 1020° C. to cause the cupric oxide to be changed to cuprous oxide. The procedure thereafter would be as already described hereinabove.

While this invention has been disclosed with reference to various specific processes, it will be understood that modifications therein may be made without departing from this invention, which is to be considered as limited only by the appended claims.

What is claimed is:

1. The process of producing a rectifier unit comprising a copper body having a layer of cuprous oxide thereon, which comprises heat treating the body to form cuprous oxide thereon at a temperature above that at which cupric oxide forms, placing the treated body while at the elevated temperature in a bath of molten salt to form a layer of the salt thereon, cooling said coated body to a quenching temperature, and, thereafter, cooling said body to about room temperature.

2. The process as claimed in the preceding claim in which said salt is selected from the group consisting of sodium chloride, a mixture of sodium chloride and lithium chloride, a mixture of potassium chloride and lithium chloride, and a mixture of lithium, potassium and sodium chlorides.

3. The process of producing a rectifier unit comprising a copper body having a layer of cuprous oxide thereon, which comprises heat treating the body to form cuprous oxide thereon at a temperature above that at which cupric oxide forms, placing the treated body while at the elevated temperature in a bath of molten sodium chloride to form a layer of the chloride thereon, cooling said coated body to a quenching temperature, and, thereafter, cooling said body to about room temperature.

4. The process of producing a rectifier unit comprising a body of copper having a layer of cuprous oxide thereon, which comprises heating the body at above 1020° C. to form cuprous oxide thereon, placing it in a bath of molten salt maintained at about 800° C., passing the body in and out of said bath until the treated body is coated with salt, allowing said body to cool to about 500° to 600° C., and, thereafter, quenching the body.

5. The process of producing a rectifier unit comprising a copper body having a layer of cuprous oxide thereon, which comprises heat treating the body to form a layer of cuprous oxide thereon at a temperature above that at which cupric oxide forms, placing the treated body while at the elevated temperature in a bath of molten salt, moving the body in and out of the bath until it is coated with the salt, allowing the coated body to cool to a temperature of about 500° to 600° C., and, thereafter, quenching said body to about room temperature.

6. The process of producing a device offering a greater resistance to current flow in one direction than in the reverse direction therethrough, which comprises heating a copper body to form cuprous oxide thereon, placing said body in a bath of molten salt, said salt being selected from the group consisting of sodium chloride, a mixture of sodium chloride and lithium chloride, a mixture of potassium chloride and lithium chloride, and a mixture of lithium, potassium and sodium chlorides, moving the body in and out of said bath until it is coated with the molten salt, and cooling said body to around room temperature.

7. The process of producing a device offering a greater resistance to current flow in one direction therethrough than in the reverse direction which comprises heat treating a copper body to form cuprous oxide thereon, placing said body in a bath of molten sodium chloride, moving the body in and out of the bath until it is coated with sodium chloride, and cooling said body to around room temperature.

8. The process of producing a device offering a greater resistance to current flow in one direction therethrough than in the reverse direction which comprises heat treating a copper body to form cuprous oxide thereon, placing said body in a bath of molten sodium chloride at about 800° C., moving the body in and out of the bath until it is coated with sodium chloride, allowing the coated body to cool to a quenching temperature, and, thereafter, cooling said body to around room temperature.

9. The process of manufacturing a copper-cuprous oxide rectifier which comprises heating a body of copper to form cuprous oxide thereon, placing said body in a bath of molten salt, said salt being selected from the group consisting of sodium chloride, a mixture of sodium chloride and lithium chloride, a mixture of potassium chloride and lithium chloride, and a mixture of lithium, potassium and sodium chlorides, moving the body in and out of said bath until it is coated with the molten salt, and cooling said body to around room temperature.

10. The process of manufacturing a copper-cuprous oxide rectifier which comprises heating a body of copper to form cuprous oxide thereon at a temperature above that at which cupric oxide forms, placing said body at its elevated temperature in a bath of a molten inorganic salt at about 800° C., to form a layer of salt on the body, said salt being selected from the group consisting of sodium chloride, a mixture of sodium chloride and lithium chloride, a mixture of potassium chloride and lithium chloride, and a mixture of lithium, potassium and sodium chlorides, thereafter, placing said body in an atmosphere at a temperature of about 500° to 600° C., and, when the body reaches the latter temperature, cooling it quickly to about room temperature.

11. The process of manufacturing a copper-cuprous oxide rectifier which comprises heating a body of copper to form cuprous oxide thereon at a temperature above that at which cupric oxide forms, placing said body at its elevated temperature in a bath of a molten inorganic salt at about 500° to 600° C., said salt being selected from the group consisting of sodium chloride, a mixture of sodium chloride and lithium chloride, a mixture of potassium chloride and lithium chloride, and a mixture of lithium, potassium and sodium chlorides, allowing the body to cool to the latter temperature, and thereafter, cooling said body quickly to about room temperature.

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