

The present invention relates to a process for the manufacture of an impregnated cathode and to a cathode obtained by this process. It finds an application in the production of cathodes for electronic tubes and
5 more particularly but not exclusively for cathode-ray display tubes.

Impregnated cathodes are commonly used to supply electronic current densities of up to 1 or 2 A/cm² as direct current and higher in pulse form.

10 In the prior art, impregnated cathodes consist of a porous body made of a refractory metal such as pure tungsten, or a mixture of tungsten either with a metal obtained from the platinum ore (mixed matrix), as known from document FR A 2 356 263, or with scandium oxide or
15 other rare earths in a low concentration (3 % to 5 % by weight).

In general, this porous body is obtained by compressing a finely divided powder of the metal (or of the mixture of metals) with an isostatic press or a
20 single-axis press.

The compact bodies thus obtained are then heated in hydrogen at an elevated temperature so as to sinter the particles to one another and to increase the density of the porous body.

25 The porous body is infiltrated with copper or plastic to facilitate machining and then machined to the desired shape. The copper or plastic is then removed by dissolving in an acid or by heating.

The porous body of the desired shape is then
30 brazed onto a molybdenum skirt which is used for maintaining the emissive pellet on one side and, on the other, a filament potted in alumina which permits the cathode to be heated. Once the filament is in position, the pores of the porous body can be filled with barium
35 and calcium aluminates. In other words, the body is impregnated with these aluminates, which form the emissive material of the finished cathode.

For this operation, the porous body is kept in close contact with an aluminate composition which is heated in a reducing atmosphere to a temperature higher than its melting point. Contact is made either by immersing the porous body in the aluminate or by placing the aluminate on the porous body. As it melts, the aluminate is diffused into the open pores and fills them by capillary action or flowing. The cathode is then mechanically and chemically cleaned to removed any aluminate residues which remain stuck to the surfaces.

Finally, the cathode is activated in a vacuum at a temperature at which the tungsten reduces the barium and calcium aluminate in order to liberate barium oxide. Metallic barium is produced in the zones where the aluminate is in contact with the refractory metal (pores). The metallic barium reaches the ends of the pores and is diffused over the entire emissive surface where, with oxygen, it forms a monolayer surface which promotes electronic emissivity by reducing the electron work function.

In addition, a film deposit with a thickness of several thousand angstroms on the emissive surface of these impregnated cathodes and made up of osmium, iridium, ruthenium or an alloy of these bodies can improve the emissivity approximately threefold.

The mixed-matrix cathode coated with a refractory metal film is known from document FR 4 2 469 792 filed in the name of the applicant.

The performance characteristics of cathodes produced by known prior art processes are satisfactory for most professional applications because high current densities can be obtained over a life span which does not limit that of the equipment in which the cathode or the electronic tube containing the cathode will be installed.

However, the known prior art processes briefly summarized above are long, complicated and costly because they include many different types of critically important

steps that must be carried out to ensure the quality of the finished product. These drawbacks make them prohibitively expensive for general public applications where the price must come down as the number of cathodes produced increases.

From Patent WO89/09480 it is also known to manufacture impregnated cathodes in a single step of pressing a mixture of powdered tungsten and aluminates.

The process according to the present invention is aimed specifically at eliminating these drawbacks. Accordingly, the invention advocates an original process which provides the advantages of impregnated cathodes and which makes it possible to obtain cathodes of equal quality but using an appreciably simplified procedure in comparison with those known from the prior art.

The characteristics of the process of the invention are those of Claim 1.

According to the invention, tungsten powder or a powder made up of a mixture of tungsten and of a metal of the platinum group or of a scandium oxide or of the three materials is mixed with a powder of aluminate, of barium and of calcium in the desired stoichiometric proportions. This mixture is then pressed into the form of pellets and sintered, in a hydrogen atmosphere, at a temperature higher than that at which the aluminates melt. This produces a blank with a consistency equal to the porous body and handleable, which is placed in a molybdenum or tantalum support by light pressing.

According to a characteristic of the invention, the mixture comprises powdered tungsten or tungsten and other materials, as above, with barium and calcium carbonates and alumina in the desired stoichiometric proportions. This mixture is then compressed and sintered at the same temperature as before. In this manner, the aluminate forms "in situ" during the sintering.

According to another characteristic of the invention, the emissive surface of the pellet obtained

using the process of the invention is coated with a film of osmium, iridium or rhenium in order to improve its emissive properties.

5 Afterwards, the filament is added and potted in the usual way, and the cathode is activated in the same way as before.

10 Thus, the invention provides a process using simplified, shorter and less costly procedures for producing coated and uncoated impregnated cathodes with single matrices (pure tungsten) or mixed matrices. It offers all the known advantages of the prior art but it involves significantly fewer steps than the prior art. This makes it possible to obtain a finished product of equal quality with fewer critical handling operations
15 and, therefore, fewer inspections.

The process according to the invention is therefore particularly suited to high-volume, low-cost industrial production of cathodes with a high current density and a relatively long lifespan, enabling their use to be
20 considered in equipment intended for general consumer products.

Specifically, the invention covers a process for manufacturing an impregnated cathode, characterized in that an emissive pellet is produced by copressing and
25 sintering a mixture of at least one refractory metal powder with a powder of barium and calcium aluminates, or with barium and calcium carbonates to which alumina has been added.

Document EP-A-0 409 275, filed on 20 July 1990, claiming a Japanese priority of 21 July 1989 and published on 23 January 1991 designating France, Germany and the Netherlands, describes a process for the manufacture of an impregnated cathode in which an emissive pellet is produced by copressing and sintering under argon atmosphere a mixture of a powdered refractory metal with
35 barium and calcium carbonates to which alumina has been added.

The invention also concerns an impregnated cathode as obtained by implementing the procedure just defined above.

Subsidiarily, the invention further concerns
5 variants of impregnated cathodes which can be produced using the process just defined above, for instance cathodes produced according to the process of the invention and then coated with a film of platinum ore metal or some other to increase their electronic
10 emissivity or to reduce the operating temperature while maintaining constant emissivity. The invention also concerns impregnated cathode variants which can be produced by adopting the actual principle of the process of the invention, for instance cathodes produced
15 according to the process of the invention but with the addition of scandium oxide or of rare earths as a complement to the mixture of the powder of a refractory metal and the aluminates or carbonates of barium and calcium. Other variants of the process of the invention
20 could easily be imagined and implemented for specific applications by a person skilled in the art in order to benefit from the advantages obtained from the invention with particular advantages known elsewhere.

The characteristics and advantages of the invention will, in any event, be made clearer from the following description and the examples which are given for illustration and do not limit the scope of the invention, and from the attached drawings wherein:

- Figure 1 is a schematic view of the main steps in a
30 simplified process according to the invention for the production of an impregnated cathode;
- Figure 2 represents a possible application of these cathodes as an emitter for a cathode-ray tube.

Figure 1 shows an example of an impregnated
35 cathode produced according to the process of the invention, illustrated in these main steps in this Figure 1.

The emissive pellet (1) is formed by conventional pressing (c) and sintering (d) of a mixture (b) of a powder (w) of at least one refractory metal and a powder (y) of barium and calcium aluminate or of carbonates of barium and calcium with alumina.

At least one of the initial powders (w) is a powder of known elements such as tungsten, molybdenum, tantalum, rhenium or alloys containing them, or a powder of an element capable of improving electronic emission, such as osmium, ruthenium, iridium or alloys containing at least one of these elements or, finally, a scandium oxide powder or particles of oxides containing scandium.

Figure 1(e) shows an emissive pellet encapsulated in a cup which will next be set (f) in a skirt (4) of molybdenum or tantalum. All that is then necessary is to add a tungsten-rhenium filament (5) coated with an insulating film (not shown) and to maintain it in the skirt (4) with an alumina "potting" body (6) as shown in Figure 1(g).

By way of explanation, the following parameters could be applied:

- the powders to be mixed will be sieved and have a mesh size of the order of 5 to 10 microns. They will then be mixed in the desired stoichiometric proportions to obtain the qualities required for the cathode. These appropriate proportions will be determined by experiment for a given application but could be, for instance: $W = 80 \%$, $Sc_2O_3 = 2 \%$, $BaO = 12 \%$, $CaO = 3 \%$, $Al_2O_3 = 3 \%$; or the tungsten powder could be replaced by a mixture of powders of tungsten and another metal, for instance: $W = 45 \%$, $Os = 35 \%$.

- The mixed powders are pressed together (c) in an isostatic or single-axis press at a pressure of the order of 10 tons per cm^2 , for instance, to form a pellet.

- The pellet is sintered (d) at high temperature (of the order of $2000^\circ C$, for example) in a hydrogen atmosphere. The chosen temperature will be sufficient to reach the

melting temperature of the aluminates contained in the pellet.

- the emissive pellet thus obtained is next mounted mechanically on a skirt (4) of Mo or Ta, if necessary
5 using a cup (3) into which the pellet will be inserted by light pressing.

The skirt (4) can be made integral with the assembly by crimping (f) onto the cup (3).

Next, the heating filament (5), previously coated
10 with a film of alumina (not shown), can be mounted in the skirt and held in place by an alumina body (6), commonly referred to as "potting". This "potting" operation can be carried out, for instance, by sintering at 1800°C in hydrogen of an alumina powder deposited with the aid of
15 a suspension around the filament inside the skirt.

If necessary, the emissive pellet could be covered with a thin metal film with a thickness of between 10 and 30000 angstroms, for instance, the metallic material being selected from the group including
20 osmium, ruthenium, iridium and alloys containing one of these elements. This film may be deposited by conventional means such as sputtering, vacuum deposition or any other suitable method.

Figure 2 is a schematic and sectional view of a
25 possible assembly of a cathode manufactured according to the process of the invention for an application as an electron emitter for a cathode-ray tube.

For this application, the assembled impregnated cathode shown in Figure 1(g) simply requires the addition
30 of a support (7) to hold the assembly at the desired point in the equipment. Since the cathode usually operates at high voltage in an electron gun, this support (7) will probably be electrically insulating and made of alumina or ceramic, for instance.

35 The advantage of the process according to the invention over the prior art is that it can be implemented with considerably fewer steps and with handling

operations which are less critical for product quality. This makes it possible to obtain more efficient production, combined with faster output and lower cost per item.

5 These combined advantages make it possible to envisage the use of these cathodes, with a performance that is comparable with those previously intended solely for professional applications because of their high price, for a wider range of applications and possibly for
10 general public applications.



CLAIMS

1. Process for the manufacture of an impregnated cathode, characterized in that an emissive pellet (1) is produced by copressing and sintering a mixture of at least one powdered refractory metal (w) with a powder (y) of barium and calcium aluminates or of barium and calcium carbonates to which alumina has been added, under hydrogen atmosphere at a temperature which is sufficient to reach the melting temperature of the aluminates.
2. Process according to Claim 1, characterized in that the said mixture of at least one powdered refractory metal contains tungsten powder mixed with the powder of a metal of the platinum ore.
3. Process according to either of Claims 1 and 2, with addition of powdered scandium oxide or rare-earth oxide in a low concentration of the order of 5 %.
4. Process according to any one of Claims 1 to 3, characterized in that the emissive pellet (1) is covered, after copressing and sintering, with a film of metal of the platinum ore.
5. Impregnated cathode manufactured according to any one of Claims 1 to 4.