

USE OF DOPED TANTALATE OF YTTRIUM, LUTETIUM
OR GADOLINIUM IN LOW-VOLTAGE LUMINESCENCE

The present invention concerns the use of doped tantalates as a luminophore in low-voltage luminescence.

It is known in the field of electronics that cathode ray tubes operate using a substantial energy of the order of 30,000V. Moreover in that type of application there is a wish to use low-energy electrons, that is to say of the order of from 200 to 800V, particularly with field emission displays (FED). In FEDs there are metallic microdots which emit low-energy electrons which excite a luminophorous material disposed on the display screen.

That luminophorous material must have two essential properties.

It must firstly have adequate optical characteristics. This involves its luminescence properties; it must emit effectively in the required colour.

It must secondly have electrical conductivity. The material must be capable of removing the charges when it is used in the above-mentioned application.

The problem lies in the difficulty of having a material which combines these two properties to a sufficient degree. In fact, the luminous effectiveness of the material decreases with excitation potential. In addition, there is a minimum excitation potential (V_{amin}), below which the material no longer has conductivity. As the desire is to use a potential range which is as low as possible, of the order of from 200 to 800V as indicated above, what is therefore needed is a material which has the lowest possible V_{amin} , while maintaining an adequate level of luminous effectiveness.

The present invention seeks to provide a material which jointly presents adequate luminous effectiveness and conductivity in a voltage range corresponding to the required use (200-800V).

The present invention accordingly provides the use of a doped tantalate of yttrium, lutetium or gadolinium as a



luminophore in the production of an apparatus using low-voltage luminescence.

The present invention also provides the use of a doped tantalate of yttrium, lutetium or gadolinium as a luminophore in an apparatus using low voltage luminescence.

It has been noted that tantalates of the above mentioned type are highly suitable for such a use in which they are subjected to low-energy electron radiation, that is to say, of the order of about at least 200V and at most about 800V.

The tantalates used in accordance with the present invention are tantalates of yttrium, lutetium or gadolinium. In addition they are doped tantalates. Doping can be effected by partial substitution either of the tantalum atoms, or of the yttrium, lutetium or gadolinium atoms.

As a doping substance for substitution of the tantalum, mention may be made of pentavalent elements such as, for example, niobium.

In addition, as a doping substance for substitution of yttrium, lutetium or gadolinium, it is possible to use a rare earth which is luminescent in the visible range, for example praseodymium, europium, terbium or thulium.

Doped mixed tantalates may be used, comprising tantalum which may or may not be doped and, besides yttrium, lutetium or gadolinium, at least one other element selected from said three elements, lanthanum and europium and, optionally, at least one doping element which may be selected more particularly from rare earths which are luminescent in the visible range. Mixed tantalates of yttrium-lutetium can be mentioned by way of example.

The content of doping element, and in particular rare earth which is luminescent in the visible range, is generally at most 20 wt% and more particularly at most 15 wt%.

Products having a monoclinic structure M are preferably used.

A certain number of tantalates which can be used in accordance with the present invention are set out hereinafter by way of example.

As blue luminophores, mention may be made of those



of formula (1) $\text{YNb}_x\text{Ta}_{1-x}\text{O}_4$, x being greater than 0 and at most equal to 0.15; those of formula (2) $\text{LuNb}_x\text{Ta}_{1-x}\text{O}_4$, x being greater than 0 and at most equal to 0.2; those of formula (3) $\text{Y}_{1-y}\text{Tm}_y\text{TaO}_4$, y being greater than 0 and at most equal to 0.03; it is also possible to envisage solid solutions of the products of formula (1) and (2) or (1) and (3).

As green luminophores, mention may be made of those of formula (4) $\text{Y}_{1-y}\text{Tb}_y\text{TaO}_4$, y being at least equal to 0.001 and at most equal to 0.15; those of formula (5) $\text{Lu}_{1-y}\text{Tb}_y\text{TaO}_4$, y being at least equal to 0.001 and at most equal to 0.15; those of formula (6) $\text{Gd}_{1-y}\text{Tb}_y\text{TaO}_4$, y being at least equal to 0.001 and at most equal to 0.15; and solid solutions of at least two of the three products of formulae (4) to (6).

Preferably the products have mean particle sizes of at most $15\mu\text{m}$, preferably at most $5\mu\text{m}$ (CILAS granulometry).

The products may be prepared by well-known processes. The usual procedure adopted involves chamotting of the oxides of the elements involved in the composition of the products, optionally in the presence of a flux comprising an alkali metal such as lithium or an alkaline earth metal such as barium.

The present invention also provides apparatus using low-voltage luminescence which comprises a doped tantalate of yttrium, lutetium or gadolinium of the above-described type.

Everything which has been described hereinbefore in regard to the use of the tantalates consequently also applies to the apparatus of the invention.

In such apparatus the tantalates are disposed on screens which are subjected to low-energy excitation. That use of the luminophores in the production of apparatus involving low-voltage luminescence may also be effected in accordance with well-known procedures, for example by deposits on the screens by means of screen printing, sedimentation or electrophoresis.

The invention is more particularly applied to an apparatus comprising a field emission display screen.

The invention is now further described in the following Examples.

As regards the luminescence properties of the

products, which are set out hereinbelow, those properties are measured by low-voltage cathodoluminescence of the product which is deposited by sedimentation without binder on a substrate which is transparent under the conditions of excitation using $1\mu\text{A}/\text{mm}^2$ direct current. The thickness of the layer of product on the substrate is $10\mu\text{m}$.

EXAMPLE 1

This Example uses an yttrium tantalate comprising niobium of a mean size of $10\mu\text{m}$ and of the formula $\text{YT}_{0.99}\text{Nb}_{0.01}\text{O}_4$.

The product emits a blue luminescence. It has a level of luminous effectiveness of $0.2\text{Lm}/\text{W}$ at 400V and a Vamin of lower than 200V .

EXAMPLE 2

This Example uses a lutetium tantalate of the formula $\text{LuTa}_{0.99}\text{Nb}_{0.01}\text{O}_4$. It has a level of luminous effectiveness of $0.12\text{Lm}/\text{W}$ at 400V and a Vamin of lower than 200V . Its colorimetric coordinates are $x=0.146$ and $y=0.069$. Its mean size is $5\mu\text{m}$.



CLAIMS

1. Use of a doped tantalate of yttrium, lutetium or gadolinium as a luminophore in the production of an apparatus using low-voltage luminescence.

2. Use of a doped tantalate of yttrium, lutetium or gadolinium as a luminophore in an apparatus using low-voltage luminescence.

3. Use according to claim 1 to 2 wherein the tantalate used is doped by partial substitution of the tantalum by niobium.

4. Use according to claim 1 or 2 wherein the tantalate used is doped by partial substitution of the yttrium, lutetium or gadolinium by a rare earth which is luminescent in the visible range.

5. Use according to claim 4 wherein the rare earth is praseodymium, europium, terbium or thulium.

6. Use according to any one of the preceding claims wherein the doped tantalate is a doped mixed tantalate comprising tantalum, which may or may not be doped and, besides yttrium, lutetium or gadolinium, at least one other element selected from said three elements, lanthanum and europium and, optionally, at least one doping element.

7. Apparatus using low-voltage luminescence which comprises a doped tantalate of yttrium, lutetium or gadolinium as defined in any one of claims 2 to 6.

8. Apparatus according to claim 7 which comprises a field emission display screen.

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