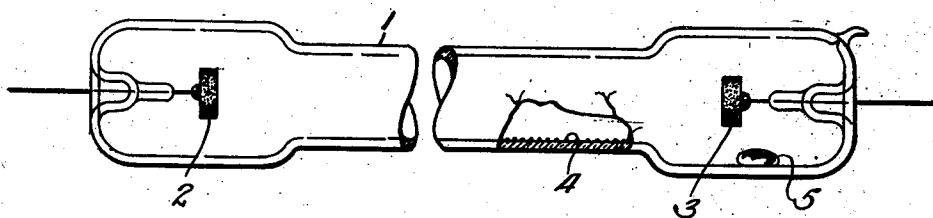


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LUMINESCENT MATERIAL

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LUMINESCENT MATERIAL

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4 Claims. (Cl. 250-81)

This invention relates to electric lamps comprising an electric discharge (more particularly through low pressure mercury vapour) and luminescent materials excited by the ultra-violet radiation and/or slow electrons from the discharge.

One of the best known luminescent materials is zinc silicate. In its usual form, known as willemite, it fluoresces with a green colour; the composition of willemite is believed to be  $2\text{ZnO} \cdot \text{SiO}_2$ , containing a trace of manganese. I have discovered that there is another form of zinc silicate, having a crystal structure different from that of willemite, which (when associated as usual with a suitable activating impurity) luminesces yellowish white when excited by contact with a mercury discharge. I believe that the main constituent of this form has the composition  $\text{ZnO} \cdot 2\text{SiO}_2$ ; but I prefer to identify it by its crystal structure as revealed by X-ray analysis. I have not yet obtained crystals large enough for the complete determination of the space-group; but the following two tables of X-ray spacings serve for identification. Table I is the X-ray spacings of my yellowish white luminescing zinc silicate and Table II is the X-ray spacings of the well known green fluorescent zinc silicate. In both tables the first column represents the distance in Angstroms between crystal planes from which X-rays are reflected with a relative intensity given in the second column. In this second column s. represents strong, w. weak, m. medium, v. very.

Table I

| Spacing (Å.) | Intensity    |
|--------------|--------------|
| 4.091        | v. s.        |
| 3.702        | w.           |
| 3.615        | m.           |
| 3.576        | m.           |
| 3.284        | m.           |
| 3.071        | w.           |
| 2.847        | s.           |
| 2.527        | s.           |
| 2.491        | s.           |
| 2.401        | v. w.        |
| 2.308        | v. w.        |
| 2.210        | w.           |
| 2.116        | m.           |
| 2.020        | m.           |
| 1.954        | w.           |
| 1.871        | w. (doublet) |
| 1.780        | v. w.        |
| 1.639        | m.           |
| 1.517        | w.           |
| 1.491        | w.           |
| 1.442        | w.           |
| 1.437        | w.           |

Table II

| Spacing (Å.) | Intensity |
|--------------|-----------|
| 4.00         | m.        |
| 3.45         | s.        |
| 2.53         | s.        |
| 2.60         | s.        |
| 2.30         | s.        |
| 2.00         | w.        |
| 1.87         | s.        |
| 1.59         | w.        |
| 1.54         | w.        |
| 1.51         | w.        |

It will be understood by those skilled in the art that it is not possible at the present stage to be certain that some of the weak spacings are not due to inessential impurities and are not therefore characteristic of the material in question.

My invention therefore comprises an electric lamp wherein a material whose main component contains zinc, oxygen, and silicon arranged in a crystal structure characterised by X-ray spacings substantially as in the foregoing table, is excited to luminescence by an electric discharge device relative to which the said material is located so that it is subjected to the ultra-violet radiation from the said discharge in the said device. Of course the usual way to expose a material to these agencies is to coat it on the interior surface of the envelope of the discharge device. The discharge device is preferably one adapted to emit the mercury spectrum, and particularly the low pressure spectrum.

The impurity whose presence is associated with the yellowish-white luminescence may be manganese. The possibility of other impurities in addition or substitution is not excluded.

In one method of preparing the material characterised by the foregoing table, zinc oxide and silica are mixed in the molecular proportions  $\text{ZnO} : 2\text{SiO}_2$ . Both must be extremely pure. The silica should be in the form of gel, which may be prepared by precipitating very pure potassium silicate with hydrochloric acid. To the mixture is added manganese nitrate in such proportion that metallic Mn forms about 0.1% of the whole mixture.

The paste so formed is dried in air at  $180^\circ \text{C}.$ , reground, and then heated in a silica boat in air at  $850^\circ \text{C}.$ , preferably for a period as long as 15 hours. In general I have found that the longer the heating, the brighter the luminescence of the product. It is not essential that there should be in the product no excess of  $\text{ZnO}$  nor of  $\text{SiO}_2$ .

Small excess of  $\text{SiO}_2$  in particular may be permitted.

The zinc silicate material characteristic of the invention may be used in conjunction with other luminescent materials and in any of the ways well-known in the art for using materials excited by ultra-violet radiation and/or slow electrons.

The accompanying drawing shows somewhat conventionally an electric lamp, embodying the present invention. At either end of a tubular glass envelope 1 filled with rare gas at a pressure of a few millimetres electrodes 2 and 3 are mounted. A thin layer 4 of zinc silicate, made according to the foregoing specification, is deposited on the inner surface of the cylindrical part of the envelope; and a globule 5 of mercury from which vapour is generated is contained within the envelope.

I claim:

1. The method of manufacturing a fluorescent material which comprises mixing pure zinc oxide and pure silica in the molecular proportions  $\text{ZnO}:\text{2SiO}_2$ , adding to the mixture a manganese compound in solution, drying the resulting paste, regrounding the dried product, and heating the resulting material to about  $850^\circ\text{C}$ .

2. The method of manufacturing a fluorescent material which comprises mixing pure zinc oxide and pure silica in the molecular proportions  $\text{ZnO}:\text{2SiO}_2$ , adding to the mixture a manganese compound in solution and in such proportion that metallic manganese forms about 0.1% of the whole mixture, drying the resulting paste, regrounding the dried product, and heating the resulting material to about  $850^\circ\text{C}$ .

3. A luminescent material emissive in the yellowish-white spectral range, said material containing zinc, oxygen, and silicon arranged in a crystal structure characterized by the following X-ray spacings:

lowish-white spectral range, said material containing zinc, oxygen, and silicon arranged in a crystal structure characterized by the following X-ray spacings:

| Spacing (Å.) | Intensity       |    |
|--------------|-----------------|----|
| 4.091-----   | Very strong.    | 5  |
| 3.702-----   | Weak.           |    |
| 3.615-----   | Medium.         |    |
| 3.576-----   | Do.             | 10 |
| 3.234-----   | Do.             |    |
| 3.071-----   | Weak.           |    |
| 2.874-----   | Strong.         |    |
| 2.527-----   | Do.             |    |
| 2.491-----   | Do.             | 15 |
| 2.401-----   | Very weak.      |    |
| 2.308-----   | Do.             |    |
| 2.210-----   | Weak.           |    |
| 2.116-----   | Medium.         |    |
| 2.020-----   | Do.             | 20 |
| 1.954-----   | Weak.           |    |
| 1.871-----   | Weak (doublet). |    |
| 1.780-----   | Very weak.      |    |
| 1.639-----   | Medium.         |    |
| 1.517-----   | Weak.           | 25 |
| 1.491-----   | Do.             |    |
| 1.442-----   | Do.             |    |
| 1.427-----   | Do.             |    |

and containing also an activating impurity.

4. A luminescent material emissive in the yellowish-white spectral range, said material containing zinc, oxygen and silicon arranged in a crystal structure characterized by the X-ray spacings set forth in claim 3 and containing manganese as the activating impurity.

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