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PHOTOCONDUCTIVE MATERIAL FOR USE IN AN ELECTRO-PHOTOGRAPHIC PROCESS

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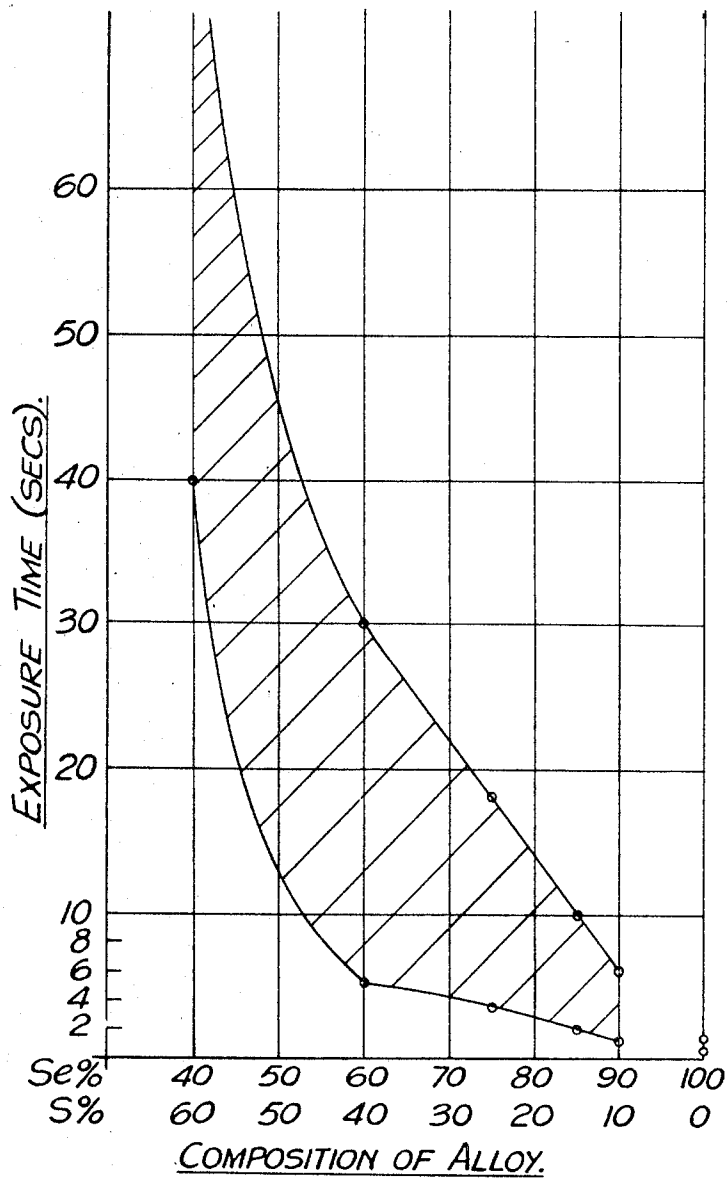

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PHOTOCONDUCTIVE MATERIAL FOR USE IN AN ELECTRO-PHOTOGRAPHIC PROCESS

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ABSTRACT OF THE DISCLOSURE

Photoconductive material useful in electro-photographic processes includes an electro-photographic member having a photoconductive layer comprising a binary alloy of a major proportion of selenium and a minor proportion of sulphur having a wide exposure range over which acceptable images may be formed, the binary alloy being prepared in situ on a surface of a support sheet which latter may be removed or permitted to remain when made of electrically conductive material.

This invention relates to a novel photoconductive material for use in electro-photographic processes. In such a process an electro-photographic member is used which includes a photoconductive layer of material, capable of being charged with and holding an electro-static charge whilst maintained in the dark and discharging the applied charge when earthed and subjected to light. By applying a light pattern to a charged layer it is thus possible to produce an electro-static image which may be developed by the application of a suitable developer.

A number of materials have been disclosed as suitable for the photoconductive layer, for example sulphur, mixtures of sulphur and selenium with sulphur predominating and amorphous selenium alone.

According to the present invention an electro-photographic member includes a photoconductive layer comprising a binary alloy of a major proportion of selenium and a minor proportion of sulphur.

Preferably the alloy includes between 5% and 25% by weight of sulphur.

In British patent specification No. 672,767 there is disclosed, as a suitable material for a photoconductive layer, a melted mixture of sulphur and selenium, with sulphur predominating. A photoconductive layer according to the present invention is distinguished from this prior art in that it comprises a binary alloy, not a simple mixture, of selenium and sulphur, and in the alloy there is a major proportion of selenium.

Contrary also to British Pat. No. 687,704 which discloses the addition of 0.1–30% of sulphur to selenium to facilitate spraying, the present invention requires the presence of sulphur as a constituent of the binary alloy forming the photoconductive layer.

Preferably the alloy is prepared by mixing selenium and sulphur together in the desired proportion, melting and fusing the mixture and then cooling the liquid mass. The photoconductive layer may be formed by coating the alloy on a surface of a support sheet by a vacuum coating technique. The layer may be built up of two or more films of the alloy applied one on top of the other by said technique.

The photoconductive layer may also be prepared by arranging for the alloying of the ingredients to take place on the surface of a support sheet, as well as by any other convenient method. The important feature is to ensure

that the photoconductive layer consists of the said alloy.

The support sheet may serve as a permanent backing, in which case it is made of an electrically conductive material. Alternatively by coating the alloy on a soluble base, the base may be dissolved away leaving a self-supporting photoconductive layer.

It has been found that while it is possible to prepare photoconductive layers from sulphur and selenium and to coat a layer of one on top of the other, none of these processes produce the same result as a photoconductive layer consisting of the binary alloy of sulphur and selenium according to this invention. For instance, if sulphur is coated upon selenium on a gloss surface, the result is a dullish gloss surface characterised by irregular but widely distributed crystal "circles." If selenium is coated upon sulphur, a blackish dull gloss matt results. In both cases of sulphur on selenium or vice versa, the photoconductive layer is very brittle and lacks adhesion. A photoconductive layer of sulphur alone has a pale yellow matt surface and a layer of selenium alone has a dark red/black surface. Adhesion is fairly good in the case of sulphur but very poor in the case of selenium. With a photoconductive layer made from the binary alloy of selenium and sulphur, however, the layer is translucent with a deep glowing red colouration and with a high gloss finish; it has better adhesive properties than either sulphur alone or selenium alone. These adhesive properties improve as the ambient temperature increases.

Exposure time is important. A photoconductive layer of selenium alone is comparatively fast and requires a critical exposure time to produce an optimum image. A photoconductive layer of sulphur alone is too slow to be of practical value. The binary alloy of selenium and sulphur, however, exhibits photoconductive properties of considerable practical value.

In the accompanying drawing there are shown some experimental results plotting exposure time against varying proportions of sulphur and selenium used in the photoconductive layer which was of approximately 20 microns thickness. The layers of different compositions were charged with 11 kv. from a single discharge wire at a height of 1 inch from the surface of the layer. Electrostatic images are formed on the photoconductive layer using as a light source a 100 watt photo-enlarger bulb arranged to give an enlargement ratio of 1:4.5 with a lens aperture setting of f.11. The electrostatic images produced were developed using a conventional powder/glass ball system and in the drawing the upper and lower curves represent the upper and lower exposures between which acceptable images were produced. From examination of the drawing it will be seen that whereas selenium alone shows a very narrow tolerance, the binary alloy of selenium and sulphur has a wide exposure range over which acceptable images can be formed. The proportional constitution of the binary alloy can be selected according to specific requirements.

In the preparation of a binary alloy of selenium and sulphur, to be used as the material for a photoconductive layer, the following procedure was adopted:

75 parts of selenium by weight were ground to produce an extremely fine and uniform powder. To this was added 25 parts of sulphur in a similar state, and the two powders were carefully mixed to produce a thoroughly uniform, fine powder. The mixture thus prepared was then melted and fused together, and thoroughly stirred so that no individual particles remained. Care was taken to ensure that the temperature at which this was carried out did not cause vaporisation of either sulphur or selenium. The whole was cooled to form the binary alloy of selenium and sulphur, of a dark brown, somewhat rubbery consistency.

The binary alloys may have varying proportions of selenium and sulphur but the procedure of preparation is the same as described above.

After the binary alloy had been prepared it was formed into a photoconductive layer for electrophotographic processes by the following procedure:

5 gr. of the binary alloy were placed in a conical aluminum vessel, and by gentle heat, fused so that the alloy stuck firmly to the said vessel. This was then placed in a previously prepared vacuum chamber in an Edwards High Vacuum Model 12E3 high vacuum coating plant. The aluminum vessel was heated by a tungsten spiral, fitted across two L.T. terminals. A conductive receiving member of aluminum was placed in position, and the chamber closed. The chamber was then evacuated to 0.1 torr, and the L.T. heat supply switch on. The temperature of the chamber was controlled to ensure that the vacuum did not exceed 0.2 torr during the coating operation. When evaporation was complete, a plate with a high gloss surface, of a deep claret-red colour, was produced, and which had excellent photoconductive properties.

The alloy can also be coated onto a suitable support by other methods such as vacuum deposition, coating, spraying, dipping.

The photoconductive layer may be also prepared by other means; one such method is by direct evaporation of a fine powder mix of selenium and sulphur in the required proportions, under vacuum, so that they condense and combine simultaneously in the required form on a suitable support.

It has been found that the properties of the photoconductive layer may be varied and in certain respects improved by applying two or more separate coatings of the alloy, the coatings thus forming a composite layer. For instance, using the reduction described above, improved members for electro-photographic purpose may be obtained by coating two or more consecutive layers of 3 gr. or 4 gr. of the alloy prepared as described above.

Electro-photographic members made from the binary alloy of selenium and sulphur in addition to possessing

the characteristics referred to above are also characterised by greater flexibility and strength than heretofore has been known and are admirably suited for coating onto flexible belts and the like.

What is claimed is:

1. The method of making an electrophotographic member including a photoconductive layer comprising a binary alloy of from about 95 percent to 75 percent by weight of selenium and from about 5 percent to 25 percent by weight of sulphur, said method comprising mixing sulphur and selenium in the desired proportions, melting and fusing said mixture at a temperature below that which would cause evaporation of the binary alloy or either constituent thereof, cooling the liquid mass, and then vacuum coating said binary alloy on a base.

2. Method according to claim **1** in which said binary alloy is vacuum coated on a soluble base, and in which said base is then dissolved away, leaving a self-supporting photoconductive layer former of said binary alloy.

3. The method according to claim **1** in which said base is flexible.

4. The method according to claim **1** in which said base is electrically conductive.

5. The method according to claim **1** in which said base is soluble.

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