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THERMOPLASTIC FILM COMPOSITION

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FIG. 1

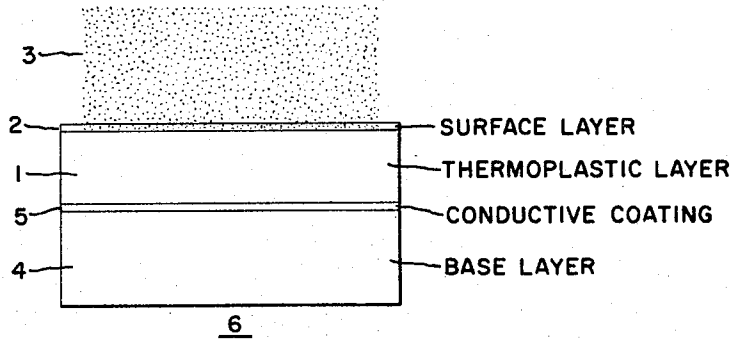


FIG. 2

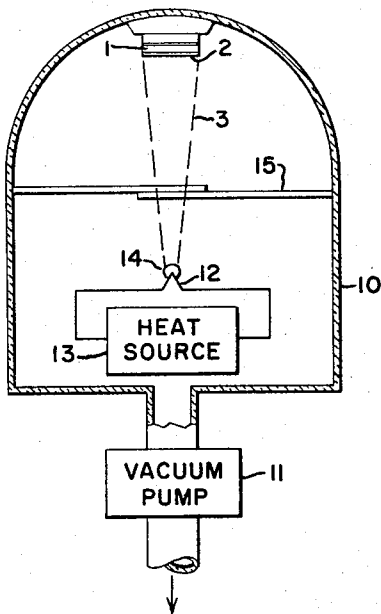
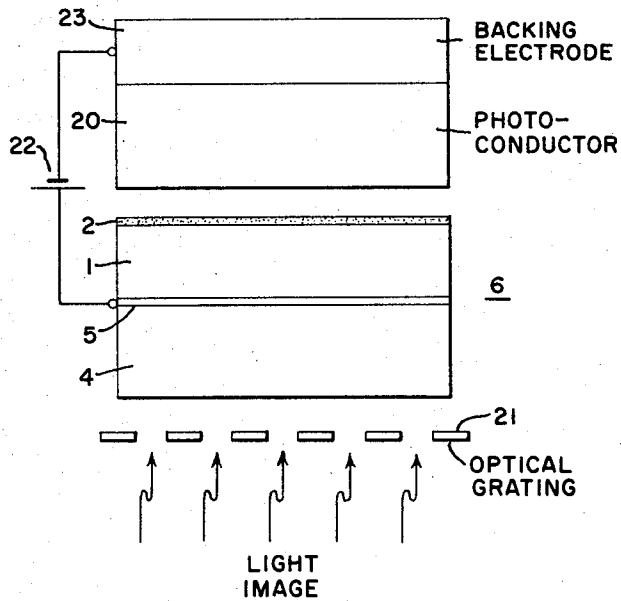


FIG. 3



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THERMOPLASTIC FILM COMPOSITION

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1 Claim. (Cl. 117-217)

ABSTRACT OF THE DISCLOSURE

A new thermoplastic recording process in which the deformation sensitivity to surface charge of the thermoplastic film is enhanced by depositing on the surface of the film an extremely thin insulating layer of silicon monoxide, having a thickness on the order of atomic dimensions, prior to formation of an image charge pattern.

The invention relates to thermoplastic film compositions and particularly to improved thermoplastic films which have an enhanced sensitivity of deformation in response to an applied surface charge. The compositions of the present invention are the type used for recording, having application to thermoplastic recording processes in general and principal application to in-air thermoplastic recording processes.

The invention relates to a copending application for U.S. Letters Patent, Ser. No. 418,339, by James F. Burgess, entitled "Thermoplastic Film Recording Media," filed concurrently with and assigned to the assignee of the present application. The instant invention constitutes a modification of the referenced copending application in providing thermoplastic film compositions exhibiting an enhanced deformation sensitivity to electrical charge of the thermoplastic surface.

In thermoplastic recording processes, information is recorded by first applying a modulated charge distribution to the surface of a thermoplastic film. The input information may be in the form of an electrical signal which modulates an electron writing beam, or more directly in the in-air thermoplastic recording process, light energy which exposes a photoconductor. The film is subsequently heated to a softened condition so as to permit the surface charge to deform the film in accordance with the charge configuration. Upon cooling of the film the information is permanently stored. The recorded information may be retrieved by means of a Schlieren optics projection system, well known to the art.

In Schlieren optics projection systems, the brightness of the display is a function of the maximum slope of the surface deformations, and therefore the maximum depth of said deformations. When considering a thermoplastic film of given structural characteristics, such as film viscosity, surface tensions, etc., the deformation depth of an elemental surface area is determined principally by the charge density applied to said elemental surface relative to the charge density on adjacent elemental surfaces. In the in-air recording process, a differential charge is formed on the surface of a thermoplastic film by means of a photoconductive member, such as by transferring charge through an air gap between the photoconductive member and the thermoplastic. The maximum charge differential that can be applied to the thermoplastic surface has been found to be inherently limited by the nature of the process, in particular by the breakdown strengths of the air gap, the photoconductor and the thermoplastic. As a result, the projected image brightness, for a given contrast ratio, is also limited.

The present invention is intended to improve this brightness characteristic. Further, for a given display brightness, the invention also permits a reduction in the requisite

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charge density applied to the thermoplastic film either with respect to in-air or electron beam writing processes, with attendant advantages of improved image resolution and lower beam currents.

It is accordingly a primary object of the invention to improve the brightness characteristic of projections employing thermoplastic film processed by an in-air recording system.

It is a further object of the invention to improve projection brightness, as above recited, by providing thermoplastic film of improved deformation sensitivity to surface charge.

It is another object of the present invention to improve recorded information resolution with respect to in-air or electron beam writing thermoplastic recording processes by employing a novel thermoplastic film of improved deformation sensitivity to surface charge.

Briefly, these and other objects of the present invention are accomplished by uniformly depositing an extremely thin insulating layer, preferably of high transparency, on the surface of a layer of thermoplastic material. The insulating layer may be formed from either a conducting or a non-conducting substance, the material being deposited in a form such as to have an extremely low lateral conductivity, so as to prevent charge migration on the surface. Application of a surface layer in this manner has been found to increase up to four fold the deformation sensitivity to surface charge of thermoplastic film.

While the specification concludes with the claim particularly pointing out and distinctly claiming the invention, it is believed that the invention will be better understood from the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a schematic diagram of a thermoplastic material being treated in accordance with the invention for improving its deformation sensitivity to applied surface charge;

FIGURE 2 is a schematic diagram of a specific apparatus which may be employed for treating a thermoplastic material so as to form the thermoplastic film of the invention; and

FIGURE 3 is a schematic diagram of an in-air thermoplastic recording apparatus employing the film composition of the present invention.

With respect to FIGURE 1, there is schematically illustrated a layer of thermoplastic material 1 having deposited on one surface thereof an extremely thin non-conducting layer 2. The layer 2 is shown to be formed from a cloud of material 3 which in its natural form can have either conducting or nonconducting characteristics. The material 3 may be deposited by a number of thin film techniques known to the art, such as evaporation or sputtering. The thermoplastic layer 1 is a conventional polystyrene material such as PS-2 Hyperclean manufactured by the Dow Chemical Corporation, having a typical thickness on the order of 25 microns. The thermoplastic material in conventional fashion is supported by a film base 4 having a conductive coating 5 at the interface.

The surface layer 2 is deposited in a uniform manner overlaying the entire extent of the thermoplastic surface so that the resulting thermoplastic film composition 6 exhibits an increased and uniform deformation sensitivity to applied surface charge. It is important that the surface layer 2 be deposited uniformly and continuously over the thermoplastic surface in order that the brightness of subsequent image projection is entirely uniform. The precise mechanism for enhancing the sensitivity of the film is not well understood. One explanation is that the surface layer retains a greater percentage of the applied charge on or near the surface of the thermoplastic material where it will exert deformation forces on the thermoplastic sur-

face. The thickness of the surface layer 2 is normally on the order of atomic dimensions, the layer being magnified many times in FIGURE 1 for purposes of illustration and appearing therefore in distorted proportion. It is essential that the surface layer 2 have an extremely low lateral conductivity so as to prevent migration of applied surface charge which would tend to wash out the recorded image. A further significant property of the layer is that it be highly transparent. It is also desirable that the surface layer have a melting temperature that is higher than that of the thermoplastic material.

When employing a conducting material in the deposition process, the material is deposited in the form of infinitesimal islands spaced sufficiently far apart so as to provide a layer having conductivity characteristics in the lateral direction that are below the ohmic region, i.e., highly insulative. Accordingly, in practice a monatomic or submonatomic thin film layer is normally formed on the thermoplastic layer. When employing a nonconducting material, the layer thickness may be slightly greater since lateral conductivity is not a limiting factor. For this embodiment, the limitations as to surface layer thickness is determined principally by its transparency and pliancy so that these properties for the overall film structure are essentially unchanged. Accordingly, the nonconducting material can be deposited in up to several atomic thicknesses.

In FIGURE 2 there is schematically illustrated a specific apparatus for applying by evaporation the thin film surface layer 2 to the thermoplastic layer 1. A bell jar 10 is employed at the upper end of which is supported the thermoplastic film. The bell jar also contains heating apparatus for evaporating the material to be deposited. An appropriate vacuum pump 11 is provided for pumping down the atmosphere within the bell jar during the evaporation process. The heating apparatus is seen to include a tungsten element 12 energized by a conventional source of energy 13, shown in block form. Deposited on the tungsten element is a sample 14 of the material to be evaporated.

One very successful material employed is aluminum, which upon being deposited on the thermoplastic surface and subsequently exposed to air oxidizes to form an aluminum oxide, believed to be Al_2O_3 . A second extremely effective material is silicon monoxide, which upon

being deposited on the tungsten element and evaporated onto the thermoplastic layer forms SiO_2 upon subsequent exposure to air. A shutter mechanism 15 is provided within the bell jar 10, which is actuated after evaporation of the heated substance is well under way. Momentary opening of the shutter aperture permits a small quantity of the evaporated material to pass through the shutter and be deposited upon the thermoplastic film.

A typical in-air recording process employing the thermoplastic film composition of the present invention is illustrated in FIGURE 3. There is shown the thermoplastic film composition 6 and a photoconductive member 20 positioned proximate one another in a facing relationship. An applied light image, transmitted through a light grating 21, illuminates the photoconductor and varies its elemental resistivity in accordance with the light intensity. Simultaneously, a transfer voltage applied by a battery 22, connected between a conducting backing plate 23 of the photoconductive member and the conducting layer 5 forms a latent charge image on the surface layer 2 of the thermoplastic film composition. The film may then be temporarily heated to allow the charge image to correspondingly deform the surface.

The appended claim is intended to include all modifications that fall within the basic scope of the disclosed invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A thermoplastic film composition comprising:

- (a) a layer of thermoplastic material, and
- (b) a thin layer of silicon monoxide, said thin layer uniformly deposited on the thermoplastic layer so as to appreciably enhance the deformation sensitivity of the thermoplastic layer to surface electrical charge, said thin layer being substantially transparent and having a thickness on the order of atomic dimensions.

References Cited

UNITED STATES PATENTS

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