

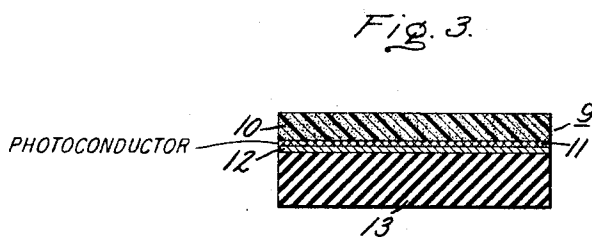
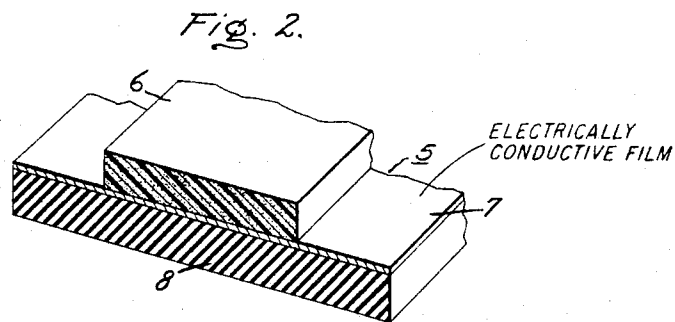
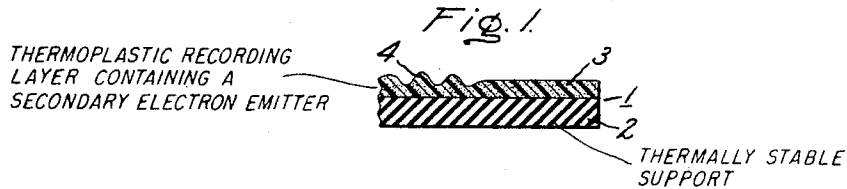
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THERMOPLASTIC RECORDING MEMBER

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THERMOPLASTIC RECORDING MEMBER

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8 Claims. (Cl. 117—201)

This invention pertains generally to the recording of information in the form of light-modifying deformations on a deformable storage member and to the retrieval of the stored information. More particularly, the present invention pertains to the recording of information as light-modifying deformations on a supported recording layer of thermoplastic material and to the retrieval of the recorded information with an electron beam. Specifically, the present invention pertains to an improved thermoplastic recording member which facilitates electron beam readout of the information stored on the surface of the recording member.

The readout of information stored on a thermoplastic film as deformations in the form of grooves or depressions with an electron beam has been disclosed in the prior copending application of John E. Wolfe and Robert G. Reeves, Serial No. 140,849, filed February 28, 1961, and assigned to the assignee of the present invention. The general method of the application involves scanning across the deformations on the surface of the thermoplastic film with a beam of primary electrons, collecting the secondary electrons which are generated from the surface as a result of the beam impingement, and deriving a measurement of the number of secondary electrons collected as a measure of the information recorded in the deformations. A preferred embodiment of the application records the information with an electron beam gun at accelerating potentials of up to 5000 or 6000 volts, develops the selective charge pattern deposited on the thermoplastic film during writing by heating the thermoplastic material above its deformation temperature, and subsequently reads out the permanent deformations produced on the film with an electron beam. Satisfactory readout is accomplished with an electron beam having a spot size of about one-half mil to one mil diameter at accelerating potentials of about 1500 volts. For reasons fully considered in the mentioned copending application so as not to warrant extensive additional discussion in the present specification, it is preferred to read out the information at a beam potential representing the cross-over voltage for the thermoplastic material in the recording member. In brief description of the intended readout process for greater understanding of the present invention, however, the electron readout beam is directed on the surface deformations of the recording member. As the primary electrons of the beam impinge the surface, secondary electrons are emitted from the surface largely in a direction normal to the slope of the deformations. In addition to the directional character of the secondary electron emission, certain primary electrons will penetrate varying distances into the thermoplastic material depending upon their electron velocity. Secondary electrons can, therefore, be generated in the material which will have to travel some distance in the solid before emitting from the surface. It is a known physical fact that if the primary electron velocity in volts of a readout beam is plotted against the ratio of number of secondary electrons emitted with respect to number of primary electrons emitted, the ratio increases almost linearly as the primary electron velocity in volts is increased. At some point, which is called the primary cross-over point or voltage, the number of secondary electrons emitted will equal the number of primary electrons impinging on the surface. Thereafter, as the primary electron velocity is increased, the number of sec-

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ondary electrons will increase over those of the primary up to some maximum value where, because of the high energy of the readout electron beam, the incident primary electrons are driven so deeply into the thermoplastic material that the secondary electrons resulting therefrom are unable to escape from the surface. Thereafter, the ratio begins to drop until it again reaches unity at a primary voltage value termed the secondary or high voltage cross-over point. At either cross-over voltage, the number of secondary electrons emitted from the recording surface will equal the number of primary electrons impinging on the surface so that electron beam readout at this point may be accomplished without creating a residual surface charge pattern to interfere with future readout. More particularly, any residual pattern of charges on the surface of the thermoplastic member gives rise to beam deflection and other results which can produce unfaithful reproduction of information stored on the member. Thus, while it is possible as reported in said mentioned copending application to read out the information at the same beam potential used for writing, it will generally be more desirable to read out at the cross-over voltage of the recording composition.

Sufficient elevation of the cross-over voltage for a thermoplastic material permits writing and readout at the same beam potential, thereby obviating any adjustment in beam potential between different steps in the information recording process. Use of the same electron gun assembly for readout as in writing also makes it possible to produce a recording device which possesses all the desirable characteristics of thermoplastic film recording, but which is less expensive than the recording devices hereinbefore used. In particular, the electrical circuits of the prior art devices contain various switching elements often including an additional high voltage power supply to vary gun potentials during the writing and readout steps in the process, which elements can be eliminated for practice of the present invention. Additionally, a smaller beam diameter may be produced at higher beam potentials. The significance of this feature is greater readout resolution so that all information recorded on the storage member is easily retrieved.

It is one important object of the invention, therefore, to provide a thermoplastic recording member having a higher cross-over voltage to facilitate recording and retrieval of information stored on the surface of a member at the same electron beam potential.

Still another important object of the invention is to provide a composite thermoplastic recording member which is particularly adapted for improved electron beam readout of the information stored on the surface of the recording member.

Still another important object of the invention is to provide a flexible thermoplastic recording layer for a recording member capable of improved electron beam readout.

These and other important objects and advantages of the invention will be more apparent from the following discussion taken in connection with the accompanying drawings in which:

FIGURE 1 is a cross-sectional view of one information storage member of the invention illustrating the information-containing deformations;

FIGURE 2 is a perspective view, partially in cross section, illustrating a portion of a different information storage member of the invention; and

FIGURE 3 is a cross-sectional view of still a different information storage member of the invention.

Briefly, the improved storage member for recording information in the form of light-modifying deformations on the recording surface of the member comprises a supported layer of thermoplastic material containing a sec-

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ondary electron emitter exhibiting a higher cross-over voltage than the thermoplastic material. A relatively uniform dispersion of a particulate secondary electron emitting material in the thermoplastic medium is preferred wherein the individual particles are of a particle size below the desired resolution of recording. With such a recording medium, there will be little, if any, opportunity to erroneously report as information any particles of the dispersed secondary electron emitting material protruding from the surface of the recording medium.

In one information storage member of the invention, secondary electron emitting particles are incorporated in a matrix of a deformable photoconductive composition with a surface layer of the admixture serving as the recording element of the member. The composite storage member which comprises a layer of the recording composition supported on a conducting substrate may be utilized to store information by a process disclosed in a copending patent application of the present applicant entitled "Information Storage on a Deformable Medium," Serial No. 79,260, filed December 29, 1960, and assigned to the assignee of the present application. In that application, the information to be stored is transmitted by activating radiation onto a uniformly charged deformable photoconductive member and by reason thereof, the photoconductive member becomes selectively discharged according to the exposure pattern of activating radiation. The selectively charged member is developed by softening the deformable medium so that forces of the electrostatic charge pattern deform the medium in accordance therewith. Upon cooling the medium, the deformations become permanently fixed on the surface of the storage member and are thereby permanently stored unless deliberately erased by heating. Retrieval of information from the deformed storage member may be obtained by electron beam readout as more fully disclosed in the aforementioned copending Wolfe and Reeves application. A detailed description of the process and apparatus for electron beam readout is contained in said latter copending application so as not to warrant further amplification in the present specification.

Another information storage member of the present invention comprises a composite flexible tape with a first thin thermoplastic layer containing a small amount of a particulate secondary electron emitting dielectric having a higher cross-over voltage than the thermoplastic material, a second flexible conducting layer adhered to the first thermoplastic layer, and a third dielectric support layer. The flexible nature of the storage member permits winding the tape around small diameter mandrels during both the information recording process and subsequent retrieval of recorded information in order to utilize conventional recording equipment and projection machines wherever suitable. The tape may also be stored in a wound condition which is an additional advantage when relatively large amounts of information are to be processed, as with computer operations and the like, for which the present system of recording is especially adapted.

Having described the invention generally, it may be practiced in its preferred embodiments as more particularly pointed out in the following detailed description of the accompanying drawings.

In FIGURE 1 there is shown a cross-sectional view of a recording member of the invention containing stored information in the form of deformations as depicted by undulations on the surface of the recording layer. The general configuration of the recording member may consist of an endless tape for convenience in recording and storage of the information as hereinbefore mentioned. Tape member 1 of the embodiment comprises a dielectric base layer 2 coated with a relatively thin thermoplastic recording layer 3 having particles of

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the secondary electron emitting material dispersed in the thermoplastic composition (as shown by the stippled condition of the thermoplastic layer in the drawing). Thermoplastic compositions for the recording layer can be generally characterized as heat-softenable resins which when heated to the liquid or softened state may be selectively deformed in response to forces of an electrostatic charge pattern deposited with an electron beam. A recording process utilizing an electron beam by which deformations may be produced on the recording surface of the present storage members is disclosed in a copending application of W. E. Glenn, entitled "Method and Apparatus and Medium for Recording," Serial No. 8,842, filed February 15, 1960, and now Patent No. 3,113,179, and assigned to the assignee of the present invention. Suitable thermoplastic compositions for recording and readout with an electron beam exhibit an electrical resistivity of around 10^{19} ohm-centimeters at ordinary temperatures with a resistivity of about 3×10^{14} ohm-centimeters and a viscosity of about 4,000 centipoises at the elevated temperatures employed to produce a deformation image. While the materials of construction for the preferred storage members in the Glenn application are optically transparent to permit readout of the deformations by transmissive optical means, the present storage members may be fabricated from light transparent or opaque materials. The suitability of opaque recording materials for construction of the present storage members is due primarily to the aforementioned contemplated method of retrieving stored information with an electron beam. The particular readout process employs a reflective principle of collecting secondary electrons emitted from the surface of the recording material responsive to the impinging electron beam so as not to be significantly affected by the optical transparency of the recording material. Addition to the thermoplastic recording composition of small amounts, generally less than about 5 percent based on the weight of thermoplastic material, of a particulate secondary electron emitting substance having a higher cross-over voltage than the thermoplastic composition produces a recording composition having all of the advantages hereinbefore described. Representative materials for construction of the present storage members will be more fully described hereinafter in the specification.

Base layer 2 of the present storage member is preferably of greater thickness than the recording layer to impart sufficient mechanical strength in the composite assembly for ordinary handling as well as to provide a heat sink for cooling the thermoplastic recording layer during the information recording process. The added mechanical strength provided by the base or support layer is desirable since the recording layer thickness is preferably 2-20 microns thick for optimum recording results. Base layer thicknesses ranging from about 25 microns to about 4 mils for a reasonably flexible material may be suitably employed in fabricating the recording member. Preferred compositions for fabricating the base layer are thermoplastic resins having a higher softening or liquid temperature than the thermoplastic material in the recording layer for providing over-all flexibility in the composite assembly as well as promoting adhesion between the recording layer and the base. Preferred base materials having the desired characteristics may be selected from the broad class of synthetic organic thermoplastic resins including polyethylene terephthalate, acetals, silicones, polycarbonates, and others.

The deformations 4 depicted on the surface of the embodied recording member comprise crests and depressions in the surface formed by movement of softened thermoplastic material responsive to the forces generated by a selective electrostatic charge pattern. The crests of the deformations are generally higher than the recording layer with the alternating depressions extending well into the surface due to the nature of the charge-forming

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mechanism. The deformation pattern can approach a regular sinusoidal shape or be quite irregular in its contour, depending upon the exact method of depositing the electron charge in the recording process. It is within contemplation of the invention to employ the present storage members with all of the various recording processes disclosed in the Glenn application, including single color recording where the deformation or groove pattern has a sinusoidal distribution as depicted in the present drawing as well as multiple color recording where the groove pattern will be irregular in some places due to the presence of several colors in the recorded information.

A suitable coating composition from which the recording layer of the above-described embodiment may be prepared is obtained by mixing approximately 5 parts of pigment grade powdered copper having a particle size less than 325 mesh U.S. screen size into approximately 1,000 parts of a 10% solids benzene solution of commercially available polystyrene resin. Further size reduction of the copper particles may be achieved by ball milling the liquid dispersion in a conventional manner for about an hour or more to improve the recording characteristics of the composition whereby the particle size of the secondary electron emitter is reduced below the width of individual deformations produced in recording. A useful polystyrene material for the composition has an average molecular weight of approximately 20,000, an electrical resistivity of around 10^{19} ohm-centimeters at ordinary temperatures, and a softening temperature of approximately 85° C. A recording tape is fabricated from the coating composition simply by overcoating a commercially available polyethylene terephthalate film with a thin layer of the liquid composition and evaporating the solvent by a conventional air drying or heating technique.

Measurement of the cross-over voltage for the above prepared recording member of FIGURE 1 was made at the secondary cross-over point in a vacuum atmosphere. The particular apparatus employed for measurement included a vacuum-tight housing containing an electron gun assembly together with a collector sphere positioned with respect to the recording layer to collect the secondary electrons emitted from the surface of the layer responsive to impingement thereon of the primary electron beam. A more detailed description of a typical measurement apparatus is disclosed in an article by N. Knoll and B. Kozan, entitled "Viewing Storage Tubes," Vol. 8, *Electronics and Electron Physics* (1956). The secondary cross-over voltage for the recording layer being measured, whereat the beam current equaled the current generated in the collector sphere, occurred at 2775 volts. In contrast thereto, a second cross-over point for a recording layer of the thermoplastic material alone was obtained at approximately 1100–1150 volts.

In FIGURE 2 there is shown a perspective view, partially in cross section of a different recording member of the invention having a general physical configuration which may again consist of an endless tape. Tape member 5 comprises a first thermoplastic recording layer 6 containing a particulate secondary electron emitting substance dispersed in the thermoplastic composition in sufficient quantity to raise significantly the cross-over voltage of the recording layer, a second conducting metal layer 7 adhering to the first layer, and a third dielectric support layer 8 adhering to and providing the substrate for the conducting layer. All layer elements of the composite member have been greatly exaggerated in thickness in the accompanying drawings for clarity of illustration, although the relative thickness of each layer is roughly in proportion to other elements in the structure. Incorporation of a conducting metal inner layer in the storage member allows heating the surface recording layer during development of the deformations by contacting electrodes, although other known means of heating such as induction heating, RF heating, and the like, may

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also be employed for this purpose. A suitable recording tape of the described configuration with sufficient flexibility for winding around small diameter mandrels may be prepared having a recording layer ranging from approximately 2–50 microns in thickness, a conducting metal inner layer ranging in thickness from about 0.001–0.1 micron, and a backing or support layer of a thermally stable synthetic organic polymer ranging in thickness between 25 microns to about 4 mils or greater. While discernible deformation images are obtained at recording layer thickness over the entire specified thickness range, it may sometimes be difficult to obtain sufficient depth of the deformations to provide a well-defined image with a layer thickness less than about 4 microns. At thicknesses of the recording layer greater than about 50 microns, many thermoplastic films are sufficiently inflexible to cause delamination in the member.

A suitable coating composition for the recording layer of the storage member in FIGURE 2 may be prepared from a 28–30 percent solids trichloroethylene solution of diphenyl siloxane polymer with a phenylene oxide polymer present in the weight ratio of 9–1 siloxane to oxide. The softening point of a particularly useful polymer mixture of polydiphenyl siloxane and poly (2,6-dimethyl-1,4-phenylene) ether is about 100–110° C., at which temperature the solid becomes a mobile sirupy liquid. Into this polymer solution there may be added 5 percent powdered magnesium oxide, based on the weight of the solid resin in solution to prepare a coating composition from which the recording layer of the storage member may be obtained.

Construction of the flexible tape member in FIGURE 2 may be commenced by vacuum depositing a thin film of metallic copper on the surface of the base polymer film and then exposing the copper layer to iodine vapor to form a conducting cuprous iodide film. A more detailed description of the method and apparatus for producing such a cuprous iodide film may be found in U.S. Patent 2,756,165, entitled "Electrically Conducting Films and Processes for Forming Same," by D. A. Lyons, issued July 21, 1956. Thin films of other metallic materials such as chromium, iron, nickel, and even such metal oxides as indium oxide, are also sufficiently flexible for use as the conducting layer of the tape. A thin surface layer of the above prepared coating composition may then be deposited on the exposed surface of the conducting layer by conventional means and the organic solvent thereafter removed to provide the final storage tape. The second cross-over voltage for the recording layer of a storage tape prepared in this manner measured 1300 volts as compared to 1200 volts for a tape of like construction but not containing the secondary electron emitting additive.

In FIGURE 3 a cross-sectional view is shown of still a different information storage member of the invention having a configuration which again may consist conveniently of a flexible endless tape. Recording tape 9 comprises a first recording layer 10 of a thermoplastic resin containing the particulate secondary electron emitting substance, a second layer 11 of a suitable photoconductor, a third conducting metal layer 12, and a fourth dielectric layer 13 providing the base support of the member. Information may be stored in the form of deformations on the recording surface of the tape in accordance with the general process disclosed in the aforementioned copending patent application of the inventor. It is not essential for successful practice of this process to have a molecular association between photoconductor and the thermoplastic recording material to obtain deformations on the surface of the latter medium. Satisfactory recordings are provided utilizing the stratified arrangement of the embodiment wherein a photoconductor layer is in direct physical association with the thermoplastic layer containing a secondary electron emitting material. Successful practice of the mentioned recording process requires some transmission of optical radiation through the recording layer, how-

ever, since the optical radiation is specifically utilized to selectively discharge the uniform charge pattern during the recording process. Sufficient transparency for recording may be achieved while still retaining an adequate level of the secondary electron emitter in the recording layer for improved electron beam readout at concentrations of 5 percent and less of an opaque additive in the thermoplastic resin. Photoconductive layer 11 of the embodiment may be prepared in conventional fashion by bonding known photoconductive materials including inorganic substances such as selenium, sulfur, phosphors, and zinc oxide, as well as such organic compounds as tetracyanoethylene, chloranil, anthracene, and even including suitable organic dyes such as crystal violet, malachite green, basic fuschin, trypanflavine, methylene blue, pinacyanol, kryptocyanine, and neocyanine. Remaining elements 12 and 13 of the embodied recording member may conveniently be of the same construction described for FIGURE 2.

While preference has been indicated in all of the above description for a recording member in the form of flexible tape for convenience in recording and storing the information, it will be realized that other recording media may also be suitably employed in the practice of the invention. For example, where it proves desirable to record information on inflexible substrates such as glass slides, metal plates, ceramic structures, and the like, certain modifications may be made in constructing the storage member. Accordingly, an information storage member having a glass slide or plate for the support element may be prepared by depositing or adhering a conducting layer to one side of the plate and overcoating the exposed surface of said layer with a coating composition of the thermoplastic recording material containing a secondary electron emitting substance. For such constructions, a conducting layer of greater thickness than hereinbefore specified may be employed consistent with the electrical requirements for grounding the recording layer during the recording process and heating the layer for development of the deformation pattern. If radio frequency heating is selected as the method of heating, an electrical resistivity for the metal layer between 1,000–10,000 ohms per square centimeter has been found optimum for developing a deformation pattern in the recording layer. Likewise, a recording member suitable for practice of the invention may be prepared simply by coating a metal plate with a recording composition comprising particles of the secondary electron emitting substance dispersed in a thermoplastic composition.

Certain characteristics in the present recording members are required to insure faithful recording of information utilizing the aforementioned recording processes. For establishment of a deformation pattern in the recording layer which faithfully reproduces the image being recorded, it is necessary to maintain the size of the secondary electron emitting particles in the recording layer substantially below the groove size of the individual deformations. Otherwise, particles on the surface of the recording layer approximating the groove size are prone to yield misleading information.

Certain physical properties of the thermoplastic compositions used for the recording material in the present information storage members are also important for optimum results. The electrical insulating characteristics of a suitable thermoplastic composition requires a resistivity of approximately 10^{19} ohm-centimeters for the solid material at room temperature with a resistivity of approximately 3×10^{14} ohm-centimeters and a viscosity of around 4,000 centipoises at the deformation temperature. For general use, the thermoplastic compositions should be solid at temperatures of at least 65° C. but be capable of being converted to a liquid by heating to temperatures of approximately 85° C., depending on the thermal stability of the substrate. If the supporting substrate for the thermoplastic composition is resistant to temperatures well above 200° C. or higher, however, then it is possible

to use thermoplastic compositions having softening or liquid points well above the 85° C. recited. Since the storage member may also have backings which do not have the thermal resistance exhibited by some of the inflexible support materials above listed, it is essential that the liquid temperature of the thermoplastic material be somewhat lower than the temperature at which the backing material may be fused or lose its mechanical strength. Suitable backings may be, for instance, glass, metal, or some heat resistant polymer such as an aromatic polyester or aromatic polyamide having a fusion temperature above 150° C. or higher (as, for instance, those described in *Journal of Polymer Science*, Vol. 40, pages 289, 418, November 1959). Additionally, it is desirable in tape constructions that the deformable thermoplastic material be sufficiently flexible and strong to enable rolling up around small diameter mandrels during storage and recording. Still other physical and rheological properties of thermoplastic compositions in the recording layer are important in tape construction, including adhesion of the composition to the substrate and lack of cold flow. Since the recording layer may comprise at least two layers, and more often three layers, it is essential that the thermoplastic composition have good adhesion to the backing material, whether it is a supporting dielectric base layer or the conducting inner layer. Absence of cold flow in the thermoplastic composition is desirable to prevent any change in configuration of the recorded information-bearing deformations as well as to prevent sticking between successive layers of a tape during storage in a rolled state. Useful thermoplastic polymers for utilization as the deformable recording material of the storage member may be selected from the class of known polymers including acetals, acrylics, polyesters, silicones, and vinyl resins having the above-described physical properties. From the above specific embodiments, it is obvious that mixtures of thermoplastic organic polymers may be employed for the recording material which satisfy all of the above requirements, and one mixture found satisfactory is a blend of polystyrene, m-terphenyl, and the copolymer of 95 percent butadiene with 5 percent styrene, in ratios of 70 percent of polystyrene, 2 percent m-terphenyl, and 28 percent of the copolymer.

Useful secondary electron emitting materials for addition to thermoplastic recording compositions exhibit a higher cross-over voltage than a thermoplastic material and may generally be characterized as individual discrete particles having a particle size less than the desired resolution of recording. Additionally, it is desirable for the emitting materials not to react chemically with the other constituents of the recording composition and to retain the desired emission characteristics after exposure to elevated recording temperatures. For reusability of the storage member, it will be necessary for the incorporated emitter to retain its integrity after heating and exposure to an electron beam. Secondary electron emitting materials having all of the described characteristics are well known and may be selected from the general class of inorganic solids including elements and compounds which exhibit either primary or secondary cross-over voltages in excess of the 1100–1200 volts obtained with thermoplastic materials. Useful secondary electron emitters include such metals as gold, silver, copper, iron, molybdenum, nickel, platinum, antimony, tantalum, tungsten, zirconium; metal oxides such as beryllium oxide, magnesium oxide, and tin oxide; salts such as potassium bromide, potassium chloride, potassium iodide, sodium bromide, and sodium chloride; and even diamond. Preferred emitters are electrical insulators of the type such as crystalline magnesium oxide to minimize conduction through the recording layer and prevent charge loss during the electrostatic charge deposition of the recording process. Crystalline magnesium oxide having a crystal diameter of at least 100–500 angstroms is an especially preferred emitting insulator material by reason of a relatively high secondary cross-over voltage in excess of 5000 volts. A detailed descrip-

tion of the emission characteristics for crystalline magnesium oxide is contained in an article of N. R. Whetten and A. B. Laponsky, entitled, "Secondary Electron Emission from MgO Thin Films," Journal of Applied Physics, 30, No. 3, pages 432-435 (1959).

From the foregoing description, it will be apparent that an improved information storage member for recording data on the surface of the member in the form of permanent physical deformations has been provided which facilitates electron beam readout of the stored information. It is not intended to limit the invention to the embodiments above shown, however, since it will be obvious to those skilled in the art that certain modifications of the present teachings can be made without departing from the true spirit and scope of the invention. For example, incorporation of a particulate emitter in the recording layer which also exhibits optically reflective properties provides a recording member which can be read out either by electron beam or reflective optical technique. It is intended to limit the present invention, therefore, only to the scope of the following claims.

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

1. An information storage member for recording information in the form of light-modifying deformations on the surface of the member which comprises a supported layer of thermoplastic material containing up to about 5 percent of a secondary electron emitter having a higher cross-over voltage than the thermoplastic material, said layer of thermoplastic material being adherently bonded to said support and having a softening point significantly lower than said support.

2. An information storage member as in claim 1 wherein the secondary electron emitter is an electrically insulating material.

3. An information storage member for recording information in the form of light-modifying deformations on the surface of the member which comprises a first layer of thermoplastic material containing up to about 5 percent of a secondary electron emitter having a higher cross-over voltage than the thermoplastic material, a second conducting layer, and a third dielectric support layer, said layers being adherently bonded together and said thermoplastic material having a softening point significantly lower than said other layers.

4. An information storage member for recording information in the form of light-modifying deformations on the surface of the member which comprises a supported thermoplastic photoconductive layer containing up to about 5 percent of a secondary electron emitter having a higher cross-over voltage than the thermoplastic material, said layer of thermoplastic material being adherently bonded to said support at an electrically conductive interface and having a softening point significantly lower than said support.

5. An information storage member for recording information in the form of light-modifying deformations

on the surface of the member which comprises a thermoplastic surface film having a photoconductor physically associated therewith, the thermoplastic film comprising a thermoplastic material containing up to about 5 percent of a particulate secondary electron emitter having a higher cross-over voltage than the thermoplastic material supported on a conducting substrate, said layer of thermoplastic material being adherently bonded to said support and having a softening point significantly lower than said support.

6. A flexible information storage tape for recording information in the form of light-modifying deformations on the surface of the member which comprises a composite of a thin layer of thermoplastic material containing up to about 5 percent of a particulate secondary electron emitter having a higher cross-over voltage than the thermoplastic material adhered to a flexible support, said layer of thermoplastic material having a softening point significantly lower than said support.

7. A flexible information storage tape for recording information in the form of light-modifying deformations on the surface of the member which comprises a composite of a first thin thermoplastic surface film containing up to about 5 percent of a particulate secondary electron emitting dielectric having a higher cross-over voltage than the thermoplastic material, a second flexible conducting layer, and a third flexible dielectric support layer, said layers being adherently bonded together and said thermoplastic material having a softening point significantly lower than said other layers.

8. A flexible information storage tape for recording information in the form of light-modifying deformations on the surface of the member which comprises a composite of a first thin thermoplastic surface film containing up to about 5 percent of crystalline magnesium oxide particles of particle size below the desired resolution of recording, a second flexible conducting layer, and a third flexible dielectric support layer comprising a thermoplastic material having a higher deformation temperature than the thermoplastic material in the surface film, said layers being adherently bonded together.

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