HOLOGRAPHIC RECORDING MEDIUM

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ABSTRACT
A holographic recording medium comprising a conductive substrate, a photoconductive layer and an electrically alterable layer of a linear, low molecular weight hydrocarbon polymer has improved fatigue resistance. An acrylic barrier layer can be interposed between the photoconductive and electrically alterable layers.

3 Claims, 2 Drawing Figures
Fic. 1

Fic. 2
HOLOGRAPHIC RECORDING MEDIUM

The invention described herein was made in the performance of work under a NASA contract and is subject to the provision of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

This is a division of application Ser. No. 309,754, filed Nov. 27, 1972, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to an improved electrically alterable recording medium. More particularly, this invention relates to an electrically alterable holographic recording medium which does not fatigue after numerous write-erase cycles.

Phase holograms can be formed on a heat softened thermoplastic surface which selectively deforms during exposure to an applied charge pattern, as has been disclosed by Urbach in U.S. Pat. No. 3,560,205. According to this system, a corona discharge device connected to a suitable recording medium ionizes the air near the surface of the thermoplastic whereupon positive ions are deposited uniformly on the surface of the thermoplastic. This surface is now exposed to an image by means of coherent light split into an object beam and reference beam in known manner. The light interacts with a photoco conductor which causes a redistribution of the charge in the areas where it impinges on the thermoplastic. When the thermoplastic is charged again, the electric field increases in the previously illuminated areas. The thermoplastic is then exposed to a temperature sufficient to soften its surface which deforms according to the electric field, becoming thinner or forming valleys in the areas of high field intensity. When cooled to room temperature, a hologram is recorded as a thickness variation or pattern in the thermoplastic. Such holograms can be erased in the absence of exposure and corona discharge by heating the thermoplastic near its softening point to a temperature sufficient to allow the surface tension of the thermoplastic to revert to its undeformed state.

This holography system would be highly useful in optical memory devices due to its ability to write and erase a series of holograms in situ. However, the thermoplastics employed heretofore gradually degrade or show fatigue after repeated write-erase cycles, when sharp, clear holograms can no longer be formed. In some cases, fatigue is discernible after several write-erase cycles.

Electrically alterable recording media described as suitable for recording deformation holograms comprise conductive substrates, a photoconductive insulating layer over the substrate and a deformable insulating ther moplastic layer over the photoconductor. The thermoplastics suggested heretofore for this system include natural resins, such as glycerol and pentaerythritol esters of partially hydrogenated resin, and synthetic polymers such as p-alpha-methylstyrene, terpolymers of styrene, indene and isoprene, polyterpene resins from 2-pinene, olefin diene resins, styrene-butadiene resins, polystyrene, coumaroneindene resins, chlorinated polyphenyl resins, styrene-acrylate copolymers, vinyltolueneacrylate copolymers, alkyd resins, mixtures of styrene and silicone resins and unreac tive phenol-formaldehyde resins.

These materials show fatigue after repeated write-erase storage cycles; in many cases the onset of fatigue is noted after a few hundred cycles. In order to be able to be incorporated into a practical optical memory system, the recording medium must be immune to fatigue over numerous write-erase cycles. Thus the search for an improved electrically alterable or deformable recording medium for holographic storage has continued.

SUMMARY OF THE INVENTION

I have discovered that linear, low molecular weight hydrocarbon polymers can be employed as the electrically alterable layer of a holographic recording medium. The resultant recording medium can withstand many write-erase cycles with no discernible change in its physical or chemical properties nor molecular structure, and it can continue to form and erase sharp, clear holograms.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of one embodiment of a recording medium of the invention and FIG. 2 is a cross-sectional view of another embodiment of a recording medium of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present holographic recording medium comprises a conductive substrate, a photoconductive insulating layer on the substrate and a linear low molecular weight hydrocarbon polymer as the electrically alterable layer on the insulating layer.

The conductive substrate is conventional, and can be flexible or rigid. It can be made of a conductive metal, such as aluminum, brass, copper and the like; or of a non-conductive substrate coated with a thin conductive layer. Suitable non-conductive substrates include glass, quartz, polymers and the like, which can be coated with a conductor such as tin oxide, copper iodide, indium oxide and the like. Preferably, the substrate is transparent. Such substrates are well known, and include glass coated with a thin, transparent tin oxide or indium oxide film, or like coated polymeric films of polyethylene terephthalate, polycarbonates, polyurethanes, acrylics and the like.

The insulating photoconductor is also conventional and can be inorganic, such as a layer of amorphous selenium, or pigments such as cadmium sulfide, cadmium selenide, zinc sulfide, zinc selenide, zinc oxide, lead oxide, lead sulfide, mercuric sulfide, antimony sulfide, mercuric oxide, indium trisulfide, titanium dioxide, arsenic sulfide, gallium selenide, lead iodide, lead selenide, telluride, gallium telluride, mercuric selenide, and the like. Alternatively, the photoconductor can be organic, such as anthracene-3-benzylidene aminocarbazole, poly-N-vinylcarbazole, 2,5-hist(p-amino phenyl-1)-1,3,4-oxadiazole, 1,4-dicyan oaphthalene, 2,4-diphenylquinazolin, 1-methyl-2-(3',4'-di hydroxymylebenzenephenol) benzimidazole and the like. These and other organic photoconductors can be complexed with Lewis acids, such as 2,4,7-trinitrofluore none, as is known. High sensitivity photoconductors such as poly-N-vinylcarbazole containing 2,4,7-trinitrofluorenone are preferred.

Nonfatiguable linear hydrocarbons useful as the electrically alterable layer have low molecular weights, i.e., about 300 to about 2000, which preferably are solid at room temperature but which have low softening points. Suitable materials include microcrystalline natural
tures excursions on pulsing, and results in further im-

provement in the life of the recording medium.

Although the reason for the efficacy of the present

materials is not completely understood, it is believed

the straight chain configuration is responsible for the

long life of the recording medium described herein,

since little cross-linking or reaction between end

groups of these straight chain molecules occurs in the

presence of high electric fields throughout numerous

cycles of softening and hardening or heating and cool-

ing.

The electrically alterable layer can be applied in any

convenient manner, but is preferably applied from

solution, as by brushing, dip coating, spraying and the

like. Electrostatic deposition can also be employed.
The electrically alterable layer must be thick enough so

that well defined hills and valleys may be formed in it

upon exposure, but the exact thickness is not critical

and can be up to 5 microns or more. Thicker layers

have deeper peaks and valleys in the holographic pat-

tern and thus may give a clearer, better defined holo-

gram; but the available holographic density, i.e., the

number of bits that can be stored in a given hologram

area, will be decreased due to spatial bandwidth.

The invention will be further illustrated by the fol-

lowing examples, but it is to be understood that the

invention is not meant to be limited to the details de-

scribed therein. In the examples, parts and percentages

are by weight unless otherwise noted.

EXAMPLE 1

A glass substrate coated with a thin, transparent indium oxide layer was dipped into a solution of poly-N-

vinylcarbazole: trinitrofluorenone (10:1) in 1:1 p-

dioxane-methylene chloride so as to apply a layer about

1-2 microns thick. Another solution of 0.35 parts of

Amber wax, a microcrystalline hydrocarbon wax hav-

ing about 60 carbon atoms per molecule in straight

chains, available from Bareco Company and having a

melting point of 88°C, softening point (Ring and ball)

of 42°C, and a Saybolt viscosity at 99°C of 75 in 40

parts by volume of n-hexane was prepared at about

60-65°C. The coated substrate was immersed in the

solution and withdrawn at a rate of 2 inches per second

so as to deposit a layer about 0.6 micron thick when the

solvent was evaporated.

Holograms were formed in the recording medium

prepared as above with a helium-neon laser using a

continuous corona discharge, writing with heat pukes

of 2-5 milliseconds in duration and erasing by applying

heat above the softening point of the wax in the ab-

sence of light, using heat pulses of similar duration.

After 7000 write-erase cycles, the recording medium

showed no sign of fatigue.

EXAMPLE 2

The procedure of Example 1 was followed except that a barrier layer was applied onto the photoconductive

layer as follows. First, 0.3 part of an acrylic resin

(available commercially as Elvacite 2013 from duPont

de Nemours and Company) was dissolved in 40 parts

by volume of acetone at room temperature. The acrylic

resin solution was spun onto the photoconductive layer

at about 1000 rpm. After evaporating the solvent, a

barrier layer about 1000 Å thick had been deposited.

EXAMPLE 3

The procedure of Example 1 is followed except that a barrier layer is applied onto the photoconductive

layer as follows. A solution containing 0.2 part of Elva-
cite 2013 in 5 parts by volume of acetone warmed to

60°C is prepared to which is added dropwise 50 parts

by volume of ethanol also warmed to about 60°C. A
glass plate having a photoconductive layer as in Example 1 is immersed in the above solution and withdrawn at a rate of 2 inches per second. A uniform barrier film about 1000 A thick is deposited onto the photoconductive layer.

I claim:

1. A medium for recording and erasing phase holograms in the form of a surface relief pattern consisting essentially of in sequence an electrically conductive substrate, a photoconductive insulating layer, a transparent, polar, barrier layer, and an electrically alterable storage layer consisting essentially of a linear, microcrystalline hydrocarbon polymer having a molecular weight in the range from about 300 to about 2000.

2. A medium according to claim 1 wherein the barrier layer is a layer of an acrylic resin up to about 0.25 micron in thickness.

3. A medium according to claim 1 wherein the barrier layer is a layer of a methyl/m-butyl-methacrylate copolymer having an inherent viscosity of 0.2 and the barrier layer is up to about 0.25 micron in thickness.

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