June 1973 B73-10166

NASA TECH BRIEF

Marshall Space Flight Center

An Improved Holographic Recording Medium

The problem:

Thermoplastics have been considered as a recording medium for holographic optical memory systems. However, the thermoplastic materials that have been considered to date gradually fatigue and degrade. After repeated write-erase cycles, sharp, clear holograms can no longer be stored on the thermoplastic surface.

The solution:

Solid, linear chain hydrocarbons with a molecular weight ranging from about 300 to 2000 can serve as a long-lived recording medium in an optical memory system.

How it's done:

Suitable recording hydrocarbons include microcrystalline waxes and low molecular weight polymers of ethylene. These hydrocarbons are unbranched, unsaturated, and have no active end groups. Why these polymers work so well it not completely understood, but it is believed that their long recording life is the result of the straight chain molecules not crosslinking on repeated heating and cooling.

A standard recording medium consisting of three layers is used: on the bottom, a conductive substrate; in the middle, a photoconductive layer; and a deformable thermoplastic layer on the top. To record an image, a corona discharge device ionizes the air near the surface of the thermoplastic. The ionized air causes positive ions to be deposited on the surface of the thermoplastic. Next, this surface is exposed to an image carried by the coherent light from the laser object and reference beams. This light interacts with the photoconductor layer to redistribute the charges on the thermoplastic.

The thermoplastic is charged again, and the electric field increases in the previously illuminated areas. Finally, the wax is heated until it becomes softened (the characteristic property of thermoplastic materials), and the charges on the wax cause the formation of hills and valleys that are retained upon cooling. The medium is erased by heating (in the absence of the coherent light) until the information-carrying shape flattens out.

Several different materials can be used in the system, but a typical example will illustrate the principles. The conductive substrate is preferably a transparent material such as glass with a thin coat of indium or other conductor. The substrate is dipped into a solution of photoconductor to deposit a 1- to 2-micron layer. The photoconductor may be inorganic or it may be an organic material such as poly-N-vinylcarbazole. Next, the coated material is dipped into another solution, this one containing the thermoplastic material. The thermoplastic (for example, a linear homopolymer of ethlyene) should be from 3 to 7 microns thick. Recording media prepared in this way have been tested with 7000 write-erase cycles with no signs of fatigue.

To allow faster thermal softening, the deformable polymer may be heat biased. In this case the polymer is kept at a temperature just short of its softening point, so that it may be softened by raising its temperature only a few degrees. When this is done, it is desirable to include a fourth layer: an "insulating barrier", between the thermoplastic and the photoconductor. A thin layer of a highly polar, transparent, acrylic resin has been used for this purpose.

(continued overleaf)

Notes:

1. NASA Tech Brief B73-10155 contains information on a holography system using this type of recording medium.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&PS-TU
   Marshall Space Flight Center, Alabama 35812
   Reference: B73-10166

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)] to the RCA Corp., Princeton, New Jersey 08540.

Source: R. A. Gange of
RCA Corp.
under contract to
Marshall Space Flight Center
(MFS-22532)