NASA TECH BRIEF

Marshall Space Flight Center

Page Composer to Translate Binary Electrical Data to Optical Form

One of the current research areas in computer equipment is the development of optical memories. A laser hologram is used to read data into or out of an optical storage medium. Such a system requires a "page composer" to convert binary data, stored or input in electrical form, to an optical form (modification of the laser object beam). The data can then be stored as a hologram. Liquid crystals, electro-optic crystals, and ferroelectric ceramics have been used to modulate the laser beam.

A new page composer has been developed consisting of an array of deformable metal membranes controlled by MOSFET's. This device is fast, produces high contrast ratios, does not degrade with extended use, and can be addressed from diverse angles: a combination of features not offered by any existing page composers.

A 4-by-4 array page composer is shown in Figure 1. A thin metallic film is mounted on a spacer attached to a substrate. There is an electrode in each hole in the spacer. Thus each hole is a capacitor in which a charge may be stored. If a charge is stored in a particular hole, the metal film over that hole will be deformed. When the object beam of a laser is directed

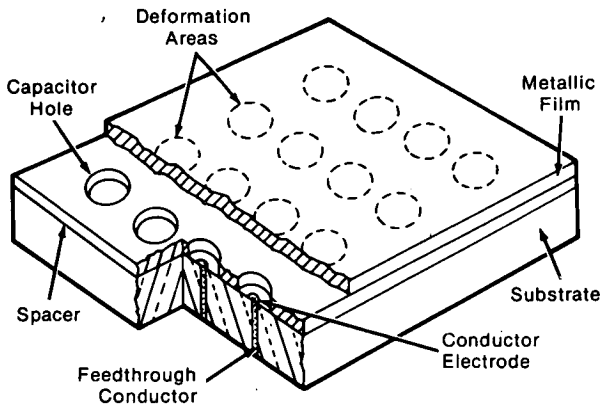

Figure 1. A Page Composer Block

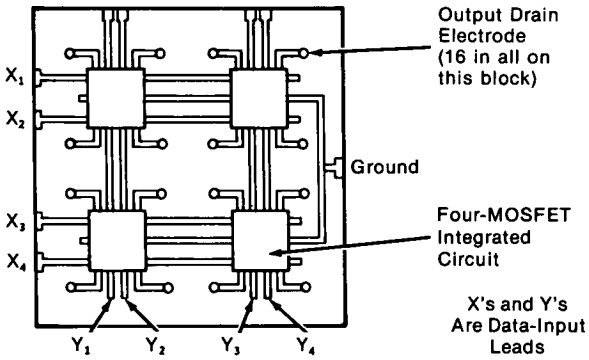

Figure 2. Underside of Page Composer

to the array, light striking the deformed portion of the surface is scattered. The remaining light is reflected to the holographic storage memory.

Individual capacitors on the page composer are charged by selectively energizing MOSFET's on the back of the substrate. The output drain electrode of each MOSFET is connected to a feedthrough conductor that ends at the electrode in the capacitor. Figure 2 shows the underside of the composer.

There are four integrated circuit chips on the back of the composer; each contains four MOSFET's. A particular MOSFET is made conductive when it is at the intersection of an energized X and an energized Y lead. An energized MOSFET causes the film to be deformed and a "0" to be written into the optical memory for that position.

A potential of about 30 V is sufficient to deform the membrane. Each capacitor-hole diameter is about 2.5 mm (10 mils), and the spacer is about 0.00125 mm (1.25 μm) thick. The substrate may be made from a glass or a ceramic, that is coated with a photoresist. The substrate is exposed according to the desired pattern; then holes are etched through it and filled with a conductive material. The electrodes may be deposited by a chrome flash followed by about 7 μm of aluminum. The unwanted material is etched away by a photolithographic process.

(continued overleaf)

The spacer is made next, from either SiO or a metal such as aluminum. It is made by the same photolithographic steps as the substrate. To make the metal membrane, a photoresist layer is deposited over the substrate and spacer, filling all the holes in the spacer and covering it. The result is dried and polished until the spacer is visible. Next, micrometer-size holes are made in the spacer to allow the solvent to remove the interior photoresist in the final steps. To form the holes, a thin film of gelatin is deposited over the chip, and a suspension of ZnS particles in water is poured over the gelatin layer and allowed to settle. Flashes of aluminum (0.06 μm) and then nickel (0.08 μm) are evaporated over the gel. The chip is subsequently wiped off with a wet tissue and rinsed. This removes the ZnS particles and leaves a metal film with micrometer-size holes where the particles were. This film is used as a seeding layer on which the full thickness of a nickel membrane is deposited. The final step is to remove the photoresist beneath the membrane by immersing the array in a dish of solvent.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Code AT01
Marshall Space Flight Center, Alabama 35812
Reference: B75-10161

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

Patent Counsel
Marshall Space Flight Center
Code CC01
Marshall Space Flight Center, Alabama 35812

Source: G. A. Bailey
Marshall Space Flight Center and
L. S. Cosentino of
RCA Corp.
under contract to
Marshall Space Flight Center
(MFS-23173 and MFS-22589)

Categories: 02 (Electronics Systems)
09 (Mathematics and Information Sciences)
03 (Physical Sciences)