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Development of Curie Point Switching for Thin Film, Random Access, Memory Device

The problem:

A need has existed for an easily entered, small size, high bit density, random access memory device which can be read out nondestructively. Prior art memory devices have included flip-flop storage means, magnetic tape recording techniques, and magnetic recording techniques on disks. Other techniques have employed individual memory cores and thin film devices based on the same principle as the magnetic core. Disadvantages of these devices and techniques included large size, low density, difficult access, and destructive readout.

The solution:

The use of manganese bismuthide (MnBi) films in the development of a random access memory device of high packing density and nondestructive readout capability. Memory entry is by Curie point switching using a laser beam. Readout is accomplished by micro-optical or micromagnetic scanning.

How it's done:

Curie point writing refers to a particular method of reversing the magnetization direction within a selected region of a film. The region is heated past its Curie temperature and then allowed to cool in a magnetic field having the direction desired for the remanent magnetization and a magnitude sufficient to insure complete switching. This magnetic field is, however, too small to affect portions of the film not having been taken through the temperature cycle.

Thin films of MnBi about 700 angstroms thick were used as the storage material. The writing was done with a bio-laser system designed for biological and biomedical research. The instrument consists of a pulsed, high-intensity ruby laser, flashlamp, focusing cavity, and a pinhole aperture which is imaged on a microscope stage. A Leitz Ortholux microscope was used with the bio-laser and the recorded bits of information were observed using the Faraday effect in MnBi with polarized light.

The intensity of the laser was attenuated sufficiently in order to heat the spots on the MnBi films above the Curie point (360°C) without destroying the material (decomposition temperature is 420°C). Since the bio-laser produces a diffraction-limited spot of one micron at the 1/e point, by properly reducing the laser intensity, spots smaller than one micron could be recorded by using only the peak of the diffraction limited intensity distribution to heat areas to the Curie point. Because of the diffraction limit on the smallest spot observable by the Faraday effect, it is estimated that the size of the smallest bits that have been recorded is less than 0.5–0.7 micron. The limitation is in the observation method rather than the material or the recording process.

The recorded bits of information when viewed through a set of crossed polarizers appear as dark (or light) spots against a light (or dark) background, depending on the setting of the axis of the analyzer.

Notes:

1. The advantages and new features characteristic of the MnBi film memory are:
   a. Smaller and lighter for a given bit density
   b. Greater bit storage capacity
   c. Fewer memory core wires and less wiring
   d. Nondestructive readout
   e. Random access
   f. Operation at much higher temperatures than prior devices
   g. Optical switching of areas as small as one micron in diameter
   h. Possible bit storage densities as great as $10^8/cm^2$

(continued overleaf)

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2. Inquiries concerning this development may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
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   Reference: B67-10633

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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