September 1971

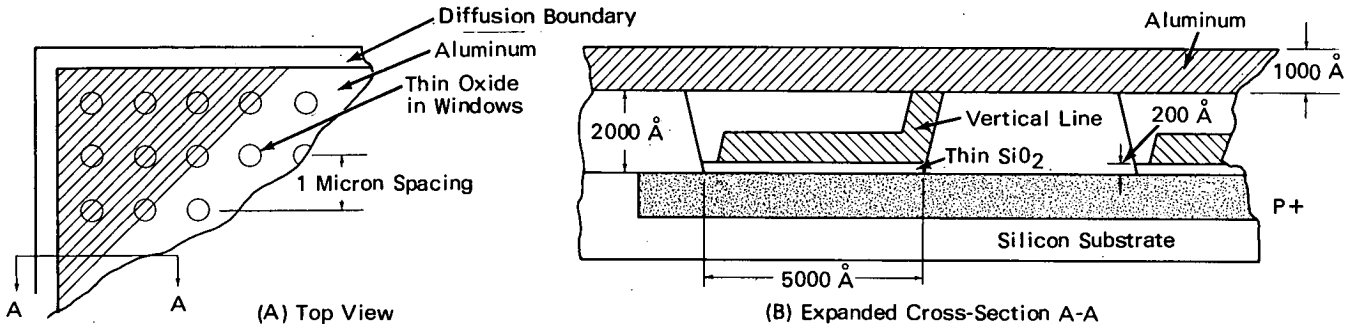
Brief 71-10346

NASA TECH BRIEF

Goddard Space Flight Center

Nonvolatile Read/Write Memory Element: A Concept

A nonvolatile read/write memory with a limited number of programming cycles may be achieved through the use of verticle, fusible links in series with oxide-breakthrough elements. The memory elements can be fabricated with integrated circuit technology and are ideal for low-power digital computer applications.



A cross-section view of a representative element (see fig.) shows the fusable link, which consists of a thin aluminum film evaporated on a silicon dioxide layer, and the oxide breakthrough element. Initially, the memory element is an open circuit. If a high voltage pulse is applied, the oxide breakthrough element changes into a conductive path and the element appears to have low resistance. A subsequent high current pulse will open the fusible link, and the memory element again appears to have a high resistance. The high and low resistance values determine the appropriate logic state.

The fabrication process consists of etching small windows, one to five micrometers in diam., in a thick oxide. An oxide approximately 200 Å is grown or deposited for the breakthrough device. A thin aluminum layer is then deposited over all of the oxide windows. An extremely thin aluminum layer is needed in order to obtain the high current density required for fusing at low input-power levels.

In operation, each memory element is programmed to be either an open circuit (OC) or a short circuit (SC). The initial OC state is achieved by opening the fuse with a large current; the SC state is achieved by breaking down the oxide with a large voltage. These operations limit the number of times that the memory can be programmed. However, since the element density exceeds 2×10^6 elements per cm^2, a sufficient number of elements are available for reprogramming; e.g., in a 256 bit memory array occupying an area of 100 × 100 mils, nearly 100 memory element pairs per bit can be obtained. This means that the memory could be reprogrammed 100 times. If a larger number of bits is required, such as 1024 bits, then the memory could be programmed more than 25 times.

Notes:

1. Related work on low current fusible links and oxide breakthrough structures is reported in

(continued overleaf)

NASA CR-106493 (N69-41187), "Read Only Memories," available through the National Technical Information Service, Springfield, Virginia 22151.

2. Requests for further information may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B71-10346

Patent status:

No patent action is contemplated by NASA.

Source: J. R. Cricchi and W. J. Lytle of
Westinghouse Electric Corp.
under contract to
Goddard Space Flight Center
(GSC-10993)