September 1971

Brief 71-10350

NASA TECH BRIEF

Marshall Space Flight Center

A Study of Nitride Devices for Computer Memory Applications

The voltage-current and voltage-capacitance characteristics of metal-nitride-oxide-silicon (MNOS) capacitors were investigated over a wide range of temperatures to determine the effects of fast and slow interface states on their performance. The MNOS samples were fabricated with nitride thicknesses of 500 Å and 2000 Å and a thermally grown oxide of 50 Å thickness. Both n-type 3.2 to 4.8Ω-cm and p-type 0.4 to 0.6Ω-cm silicon substrates were used, with the orientation in the (111) direction. An aluminum contact with a radius of 0.102 cm was deposited on the nitride surface.

A detailed analysis of the data was based on the assumptions that the modes of charge flow within the device included conduction due to tunneling from the silicon into the oxide conduction band, then drifting to the nitride, and finally conduction in the silicon nitride due to repeated excitations from traps into the nitride conduction band.

Conclusions derived from the analysis of the experimental measurements indicate that the MNOS capacitor acts like an MNS capacitor with an extra interface where a sheet of charge can be stored in slow states. In addition, the flatband voltage can be shifted any desired amount, over a wide range of voltages, by adjusting the stored charge density. The conduction mechanism in the nitride layer appears to be primarily the Frenkel-Poole effect with an ohmic contribution at low fields. At high fields, the shape of the curves for the field emission and Frenkel-Poole are similar, indicating that field emission may possibly occur. Field emission could also be related to the onset of breakdown. The nitride conduction mechanisms so completely overshadowed those of the thin oxide layer that nothing definitive could be said about the latter. The C-V hysteresis loop exhibited none of the predicted distortions due to fast surface or interface states, indicating that these would not be a problem if the devices were to be used in computer memory applications.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Code A&TS-TU
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B71-10350

Patent status:

No patent action is contemplated by NASA.

Source: W. D. Raburn of
The University of Alabama
under contract to
Marshall Space Flight Center
(MFS-20971)

Category 03