MODELING OF SONOS MEMORY CELL ERASE CYCLE

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INTRODUCTION

• Utilization of Silicon-Oxide-Nitride-Oxide-Silicon (SONOS) nonvolatile semiconductor memories as a flash memory has many advantages.
• These electrically erasable programmable read-only memories (EEPROMs) utilize low programming voltages, have a high erase/write cycle lifetime, are radiation hardened, and are compatible with high-density scaled CMOS for low power, portable electronics.
• In this paper, the SONOS memory cell erase cycle was investigated using a nonquasi-static (NQS) MOSFET model.
• Comparisons were made between the model predictions and experimental data.

SONOS Device

• The modeled SONOS device is shown in Figure 1.

![Figure 1: SONOS Device Layout](https://ntrs.nasa.gov/search.jsp?R=20110015784)

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>CONTROL</th>
<th>FLOATING GATE</th>
<th>TUNNELING OXIDE</th>
<th>DRAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-TYPE SUBSTRATE</td>
<td></td>
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</tbody>
</table>

- \[ V_{FG} = V_{FG} - V_{GB} + C_{ox}(V_{FG} - V_{MIN}) + C_{ox}(V_{FG} - V_{GB}) + C_{ox}(V_{FG} - V_{GB}) \]

• During Erase cycle device is in accumulation mode
• \( \phi_0 \) should be on the order of a few hundredths of a volt and can be neglected

RESULTS

• For the SONOS erase operation \( V_{GB} \) was set to -8 VDC, \( V_{DB} \) and \( V_{SB} \) were set to 0 VDC.
• The calculated floating gate voltage is shown in Figure 3.

![Figure 3: Gate Voltages](https://ntrs.nasa.gov/search.jsp?R=20110015784)

• The calculated tunnel current is shown in Figure 4. The calculated threshold voltage and the threshold voltage from the Cho & Kim device is shown in Figure 5.

![Figure 4: Tunnel Current](https://ntrs.nasa.gov/search.jsp?R=20110015784)

CONCLUSION

• A nonquasi-static model was developed for the SONOS memory cell erase cycle.
• The floating gate voltage, tunnel current, and threshold voltages were calculated based on the SONOS device parameters.
• The calculated threshold voltage curve had a slightly different slope than the threshold voltage curve from the Cho & Kim device, but there was still fairly good agreement between the two curves.

REFERENCES