Neutron radiation effects on metal oxide semiconductor (MOS) devices

Abstract

The main purpose of this study is to provide the knowledge and data on Deuterium-Tritium (D-T) fusion neutron induced damage in MOS devices. Silicon metal oxide semiconductor (MOS) devices are currently the cornerstone of the modern microelectronics industry. However, when a MOS device is exposed to a flux of energetic radiation or particles, the resulting effects from this radiation can cause several degradation of the device performance and of its operating life. The part of MOS structure (metal oxide semiconductor) most sensitive to neutron radiation is the oxide insulating layer (SiO2). When ionizing radiation passes through the oxide, the energy deposited creates electron-hole pairs. These electron-hole pairs have been seriously hazardous to the performance of these electronic components. The degradation of the current gain of the dual n-channel depletion mode MOS caused by neutron displacement defects, was measured using in situ method during neutron irradiation. The average degradation of the gain of the current is about 35 mA, and the change in channel current gain increased proportionally with neutron fluence. The total fusion neutron displacement damage was found to be 4.8 × 10-21 dpa per n/cm2, while the average fraction of damage in the crystal of silicon was found to be 1.24 × 10-12. All the MOS devices tested were found to be controllable after neutron irradiation and no permanent damage was caused by neutron fluence irradiation below 1010 n/cm2. The calculation results shows that (n,α) reaction induced soft-error cross-section about 8.7 × 10-14 cm2, and for recoil atoms about 2.9 × 10-15 cm2, respectively. © 2009 Elsevier B.V. All rights reserved.