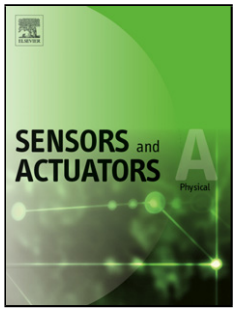

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The Gamma Irradiation Responses of Yttrium Oxide Capacitors and First Assessment Usage in Radiation Sensors

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Abstract

Co-60 gamma irradiation responses of the Y_2O_3 MOS capacitors were investigated, and initial assessment of the Y_2O_3 dielectrics used in gamma radiation sensors was discussed. We analysed the effects of applied radiation from flat-band and mid-gap voltage shifts, and also capacitance–voltage measurements were obtained before and after irradiation. It has been observed that the measured capacitance is almost constant with irradiation and the basic modification in flat band shifts toward more positive voltages due to negative charge accumulation, thanks to trap centres in the MOS capacitors. The reason of negative charge trapping in the devices structure may be attributed to ionized Yttrium atoms and cluster of the oxygen vacancies occurred by irradiation. Also, a linear dose- flat band relation has been observed, and irradiation sensitivity was found to be 10.8 ± 0.43 mV/Gy for Y_2O_3 calculated for five different capacitors, which is more sensitive than the conventional SiO_2 dielectric layers. The higher sensitivity is probably due to the high trapped efficiency in the Y_2O_3 dielectrics. On the other hand, the generated oxide traps densities increase with irradiation while interface state density trend varies by irradiation. This behaviour for interface states was attributed to the passivation of the dielectric layer from the semiconductor. The charge accumulation in the MOS capacitors is in the order of 10^{10}-10^{11} cm^{-2} for the given dose range. This did not cause any significant device degradation through its operation. Consequently, the irradiation does not significantly affect the device operation. Especially, for radiation measurements system with linear dose performance and sensitivity, Y_2O_3 may be a promising future gate dielectric material candidate for radiation sensors in given radiation dose range.

Keywords: Alternative dielectric film, Y_2O_3 MOS capacitors, oxide trapped charges, radiation effects, radiation sensors

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