Influence of the hydrogen post-annealing on the electrical properties of metal/alumina/silicon-nitride/silicon-oxide/silicon capacitors for flash memories

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Abstract : Recently, Metal/Alumina/Silicon-Nitride/Silicon-Oxide/Silicon (MANOS) structures are one of the most attractive candidates to realize vertical scaling of high-density NAND flash memory [1]. However, as ANO layers are miniaturized, negative and positive bias temperature instability (NBTI/PBTI), such as the flat band voltage shift, $\triangle V_{FB}$, the interfacial trap density increase, $\triangle D_{it}$, the gate leakage current, $\triangle I_{G}$, and the retention characteristics, in MONOS capacitors, becomes an important issue in terms of reliability. It is well known that tunnel oxide degradation is a result of the oxide and interfacial traps generation during FN (Fowler-Nordheim) stress [2]. Because the bias temperature stress causes an increase of both interfacial-traps and fixed oxide charge could be a factor, witch can degrade device reliability during the program and erase operation. However, few studies on NBTI/PBTI have been conducted on improving the reliability of MONOS devices.
In this work, we investigate the effect of post-annealing gas on bias temperature instability (BTI), such as the flat band voltage shift, $\triangle V_{FB}$, the interfacial trap density shift, $\triangle D_{it}$, retention characteristics, and the gate leakage current characteristics of MANOS capacitors. MANOS samples annealed at 950 °C for 30 s by a rapid thermal process were treated via additional annealing in a furnace, using annealing gases N_2 and N_2-H_2 (2 % hydrogen and 98 % nitrogen mixture gases) at 450 °C for 30 min. MANOS samples annealed in N_2-H_2 ambient had the lowest flat band voltage shift, $\triangle V_{FB}$ = 1.09/0.63 V at the program/erase state, and the good retention characteristics, 123/84 mV/decade at the program/erase state more than the sample annealed at N_2 ambient.

Key Words : MANOS, NBTI/PBTI, flat band voltage shift, retention

Reference

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