Abstract #778, 223rd ECS Meeting, © 2013 The Electrochemical Society

Improved Characteristics of GaSb MOS Capacitors by Ozone Post Deposition Treatment

Lianfeng Zhao, Zhen Tan, Jing Wang, and Jun Xu*
Tsinghua National Laboratory for Information Science and Technology, Institute of Microelectronics,
Tsinghua University, Beijing 100084, P.R.China

As a promising candidate channel material for PMOS mobility enhancement for next generation CMOS technology, GaSb are intensively investigated[1]. However, widely application of GaSb materials is impeded by many issues, such as high interface state density (Dit).

In this paper, In-situ Ozone post deposition treatment is investigated to improve the performance of GaSb metal-oxide-semiconductor capacitors (MOSCAPs), especially for reducing the gate leakage current and Dit. It is found that after in-situ Ozone post deposition treatment for 5 minutes, the lowest interface trap density is reduced by ~10%, achieving $\sim 1.9\times 10^{12}\ \mathrm{eV^{-1}cm^{-2}}$, and the gate leakage current is reduced as well, which indicates that Ozone post deposition treatment is a promising technique for improving the performance of GaSb MOS devices.

The fabrication of GaSb MOSCAPs is as follows. First of all, n-type Te-doped GaSb substrates with a doping concentration of $\sim 10^{17}\mathrm{cm^{-3}}$ were used. The substrates were firstly degreased by sequentially rinsing for 5 minutes each in acetone, ethanol, and isopropanol, and cleaned by 9% HCl for 1 minute. Then sulfur passivation was carried out by immersing the substrates into 15% aqueous $(NH4)_2S$ solution for 15 minutes at room temperature. After that, ~5nm Al_2O_3 dielectrics were deposited by atomic layer deposition (ALD) for 50 cycles, which is followed by in-situ Ozone post deposition treatment for 5 minutes. Finally, Gate contacts ~300nm thick were formed by e-beam evaporation of Al. Back metal contacts of Au were also deposited. Control samples without Ozone treatment were also fabricated.

Figure 1 shows the gate leakage current density of n-type GaSb MOS capacitors with and without the in-situ Ozone post deposition treatment. The reduction of gate leakage current density after Ozone treatment indicates that the quality of the Al_2O_3 dielectric is improved. Figure 2 shows the multi-frequency C-V characteristics of the MOSCAP with in-situ Ozone post deposition treatment for 5 minutes. Figure 3 shows the typical measured parallel G_p/ω versus frequency for various gate bias of the MOSCAP with in-situ Ozone treatment for 5 minutes. The Dit distribution is extracted using the conductance method[2], as is shown in Figure 4.

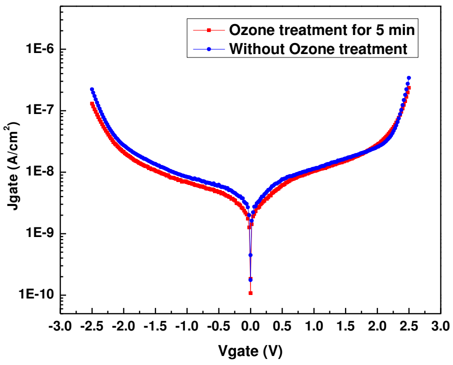

Figure 1. Gate leakage current density of MOSCAPs with and without Ozone treatment.

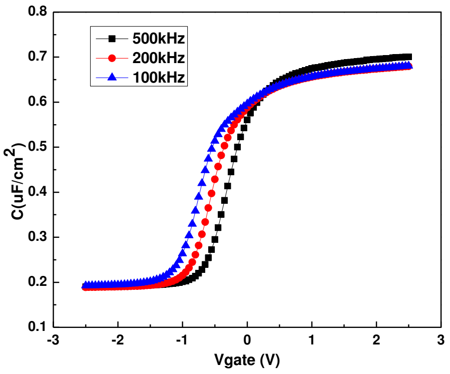

Figure 2. Multi-frequency C-V characteristics of MOSCAP with in-situ Ozone post deposition treatment for 5 minutes.

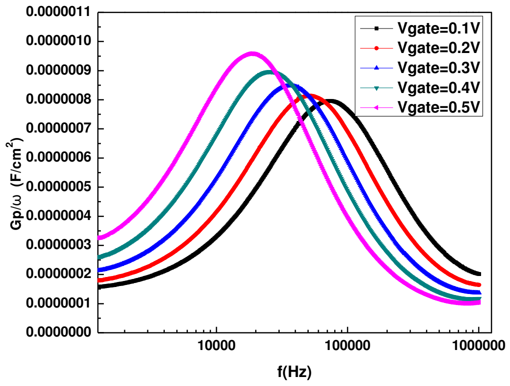

Figure 3. Typical measured parallel G_p/ω versus frequency for various gate bias of the MOSCAP with Ozone treatment for 5 minutes.

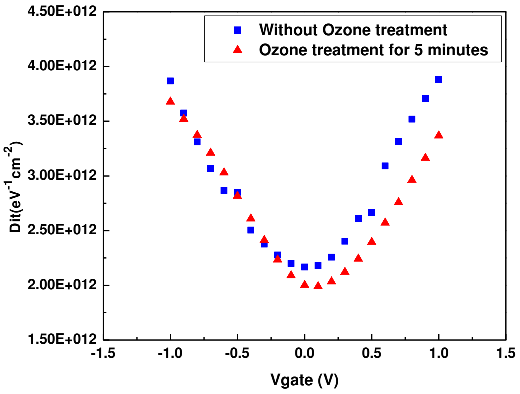

Figure 4. Interface trap density (Dit) distribution extracted by conduction technique. Dit is reduced after Ozone post-deposition treatment.

References

1. C. Wang, M. Xu, J. Gu, D. W. Zhang and P. D. Ye, Electrochem. Solid-State Lett, 15, H51 (2012).
2. E. Nicollian and A. Goetzberger, Bell Syst. Tech. J, 46, 1055 (1967).