To form a memory cell, it is essential to epitaxially grow high quality pnp stack 3C SiC on Si. It requires a SiC seed, p type, n-type and p type 3C-SiC to be realized. The distributions of the elements in the film will be largely decided by the processes performed for the different purposes. To verify the distribution of the elements with depth, SIMS can be a sensitive and informative technique for the characterization of SiC on Si. A great deal of information about C, Si, Al, N, and impurities, and structural defects may be obtained from SIMS measurement.

The most common doping elements in SiC during epitaxial growth are aluminium for p type and nitrogen for n type. A novel one-off pnp SiC epitaxial process was established in our lab which is stands as the only facility in the world that can produce such wafers.

In this report, I present chemical evidence in the form of SIMS profiles to show the presence of aluminium and nitrogen in our 3C-SiC epilayers grown at 1200°C.

From the results generated by this investigation of the epi-layer SiC and Si, temperature effect on doping has been found in our process. It implies we could adjust the doping concentration by deposition temperature.

In this report, I also represent the chemical elements distributions on gate oxide on 4H-SiC which is a major barrier for a reliable MOSFET fabrication. Currently, MOSFET based on 4H-SiC is a world wide technical difficulty academically and industrially. The key issue is to improve the thermal gate oxide on SiC. By using a novel oxidation process technique, we have successfully demonstrated a significantly improved gate oxide on 4H-SiC. To disclose the mechanism of the improvement, SIMS measurement has been performed to demonstrate the chemical element distributions which directly reflect how the oxidation works in the oxidation process.

To date, we have been developing and testing several sequential approaches for SiC epi-layers binding in p-type and n-type doping. Gate oxidation process has been investigated also for the electron mobility improvement for a 4H-SiC based MOSFET.

Our project has been significantly benefited by the AINSE funding support. The SIMS investigation indicates the high quality of SiC layer on Si and gate oxide on SiC, which puts our research group in one of the leading positions within the world SiC community.
TMAl flow = 0.15 sccm  
Doping level by hotprobe = 3x10^{18} cm^{-3}  
Oxygen is detected at levels of 1x10^{20} cm^{-3}. This seems unreasonably high.  
There are more Al counts in F1186 (1200°C) than F1196 (1250°C) despite there are similar counts for N and O  
Conclusion: less Al doping concentration at higher epi-temperature.

SIMS measurement on SiO2/4H-SiC

There are more Al counts in F1186 (1200°C) than F1196 (1250°C) despite there are similar counts for N and O  
Conclusion: less Al doping concentration at higher epi-temperature.
N accumulates at the interface of SiO₂ and SiC which passivate the interface dangling bonds and improve the gate oxide performance.

Conclusion: The doping concentration on epitaxial temperature has been investigated by SIMS. The experimental result has shown that a less Al concentration indicates a higher epitaxial temperature.

SIMS shown the oxidation process performed in our lab successfully demonstrated a passivated interface between SiC and SiO₂ being formed which would improve the electron mobility of the SiC based MOSFET.

PUBLICATIONS / REPORTS arising as a result of your work.


PhD STUDENTS

Daniel Haasmann, a PhD student, involved with the project SIMS analysis on SiO₂ on SiC, his thesis is going on.