

Depth profiles of impurities in the Semi-conductor material by TOF-SIMS I-9

Unique information can be acquired by using TOF-SIMS on Semi-conductor device. TOF-SIMS enable to (1) analyze small area less than $10\ \mu\text{m}$, (2) analyze with high mass resolution mode on the samples with thin multi-layers, (3) qualify and quantify impurities for a specified depth.

Table 1 Characterization on depth profiling of impurities by TOF-SIMS

Mode	Detection limit	Spatial resolution	Depth resolution	Mass resolution
High spatial resolution mode	10~100 ppm	$0.5\ \mu\text{m}$	1~5 nm	400
High mass resolution mode	ppm	5~10 μm	1~5 nm	5000

Depth profiles of passivation layers on SiC MOSFET (High spatial resolution mode)

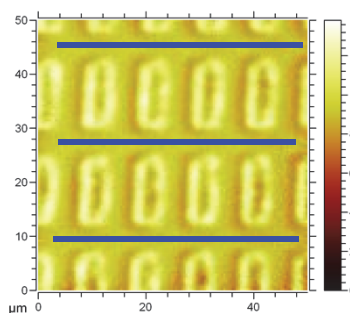


Fig.1 Secondary ion image (Total elements, $50\ \mu\text{m}$ □)

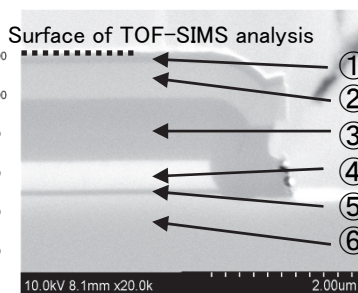


Fig.2 Cross-sectional SEM image

In order to reconstruct depth profiles at Gate region, secondary ions were extracted from rectangles colored blue in Fig.1. The area is about 2 times $40\ \mu\text{m}$. Depth profiles of impurities can not be obtained in such a small area by other analytical techniques except for TOF-SIMS.

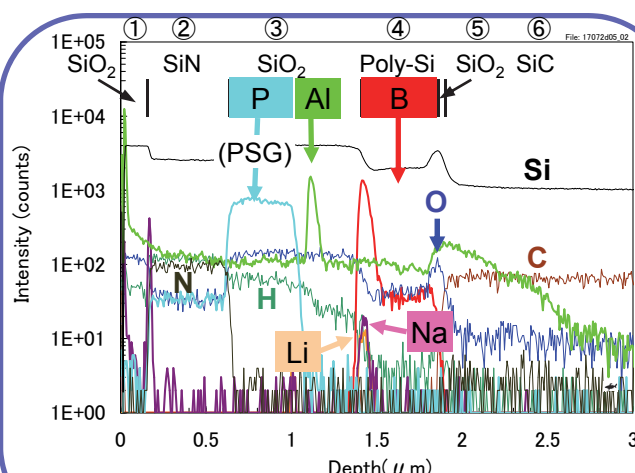


Fig.3 Depth profiles extracted at Gate region from blue rectangles in Fig.1

Si and F profiles in AlGa_{0.3}N (High mass resolution mode)

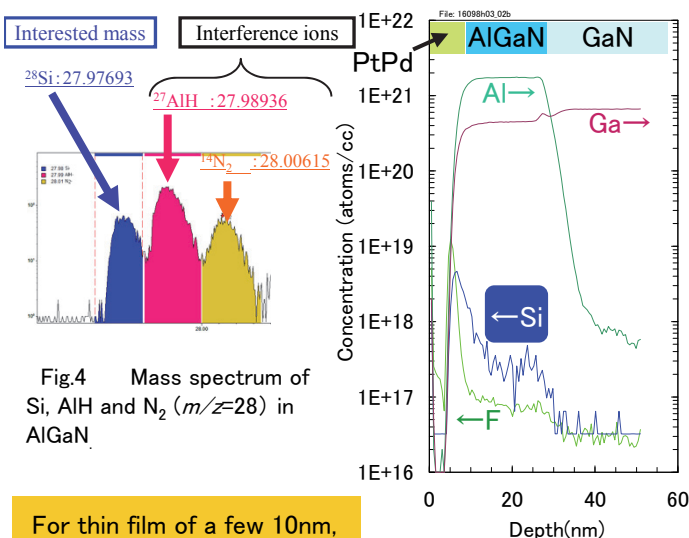


Fig.4 Mass spectrum of Si, AlH and N_2 ($m/z=28$) in AlGa_{0.3}N.

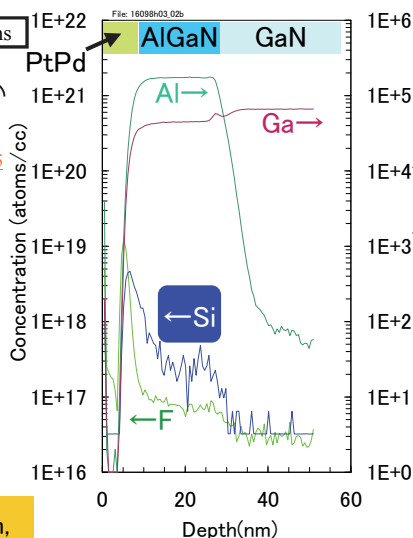


Fig.5 Depth profiles of Si and F in AlGa_{0.3}N. Both elements are able to be detected with the detection limit of $10^{16}\text{atoms}/\text{cm}^3$ level.

Qualitative and Quantitative analysis on SiO₂/SiC

Table 2

element	concentration
Li	<3E15
Be	<1E17
B	3E17
N	<5E19
Na	<2E15
Mg	<2E16
Al	1E17
K	3E16
Ca	<2E16
Ti	<4E15
V	<3E15
Cr	<6E15
Mn	<1E16
Fe	<4E17
Co	<4E16
Ni	<4E16
Cu	<4E16
Zn	<2E18
Ga	<2E15
Y	<2E15
Zr	<4E15
Mo	<7E16

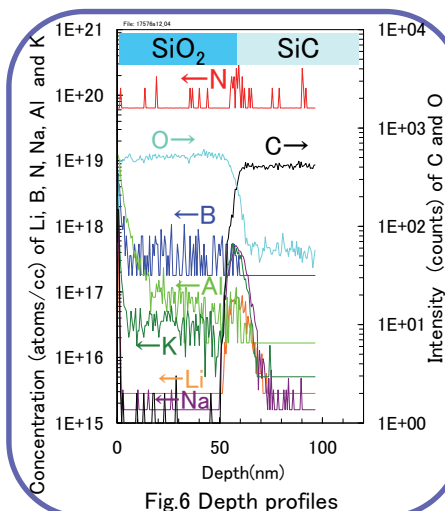


Fig.6 Depth profiles

Table 2 shows the concentration of metallic elements in SiO₂. Fig.6 shows depth profiles in SiO₂/SiC of some elements in Table 2.

Qualitative and quantitative analysis can be performed on a thin film such as 50nm thickness.