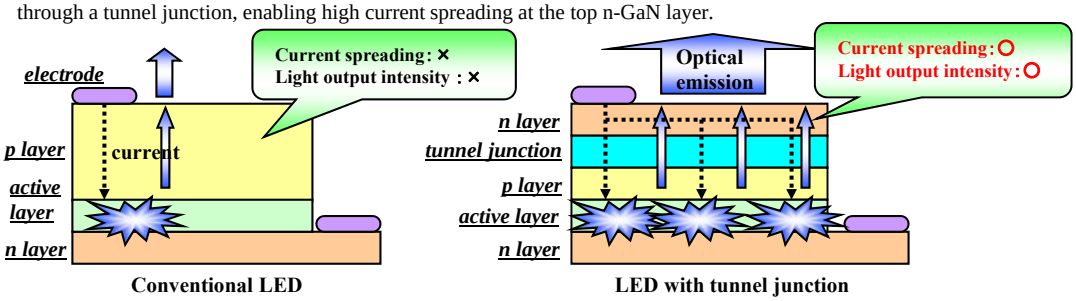
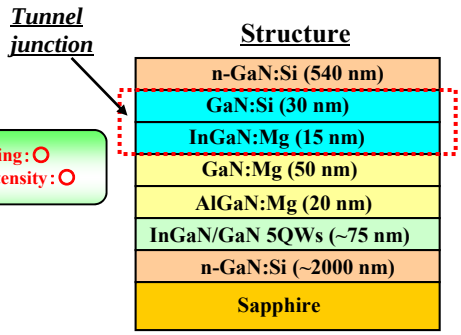
SIMS Analysis of Dopants in GaN LED

A novel GaN-based LED was analyzed with dynamic SIMS equipped with two ion sources: Cs^+ and O_2^+. The Cs^+ primary ions can offer quantification of AlN mole fraction in $Al_xGa_{1-x}N$ layers with high depth resolution, whereas the O_2^+ ions provide high sensitivity for Mg with no mass interferences. In addition, the simultaneous detection of both Mg and Si was achieved with the use of O_2^+ primary ions.

Structure of GaN-based LEDs with tunnel junctions

Typically, the resistivity of p-GaN is two orders higher than that of n-GaN, resulting in poor current spreading in p-GaN layers. The novel LED employs hole injection through a tunnel junction, enabling high current spreading at the top n-GaN layer.

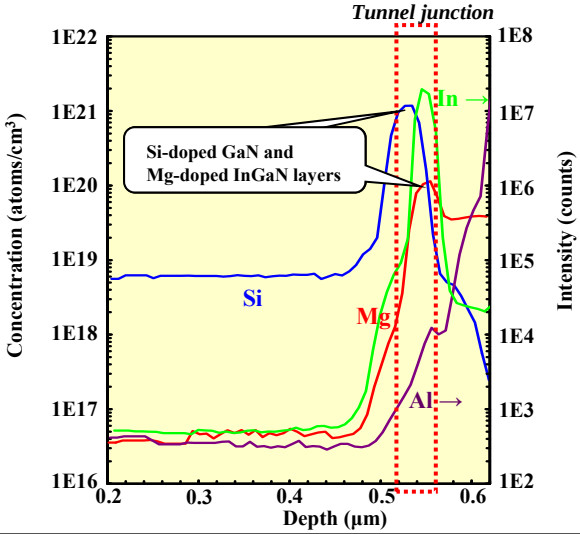




LED with the tunnel junction was supplied by Mejo University.

Simultaneous Analysis of Mg and Si by O_2^+ ions

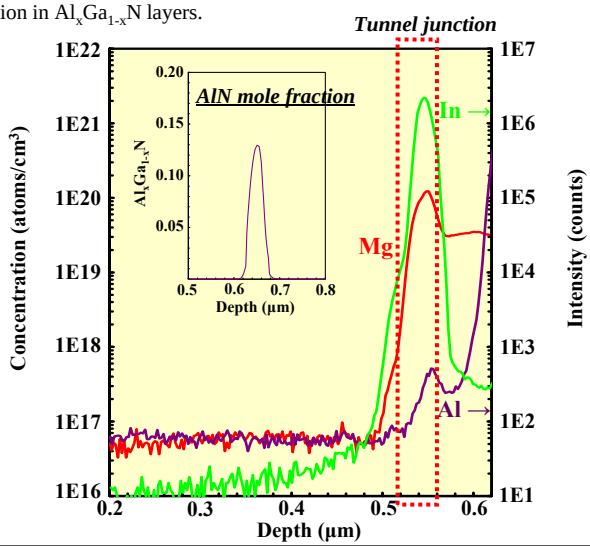
In general, depth profiling of Mg and Si is separately taken by detecting $CsMg^+$ and Si^-, respectively. However, in order to evaluate the performance of the tunnel junction, it requires information about overlapping region of Mg and Si profiles. Here, we simultaneously took both Mg and Si profiles in the tunnel junctions with the use of O_2^+ primary beam by detecting Mg^+ and Si^+.



- Simultaneous detection of Mg and Si
- High sensitivity for Mg

Quantification of AlN mole fraction by Cs^+ ions

The Cs^+ primary ions can suppress a growth of surface roughness compared to the O_2^+ ions, and thus provide better depth resolution. The Cs^+ beam also enables us to detect molecular ions such as $CsMg^+$, which can reduce the change of ionization probability in matrix composition (matrix effect). In addition, the Cs^+ ions can provide depth profiling of AlN and GaN mole fraction in $Al_xGa_{1-x}N$ layers.



- High depth resolution
- Quantification of AlN mole fraction

Comparison of detection limits between O_2^+ and Cs^+

	Detection limit (atoms/cm³)					Depth resolution	Quantification of AlN mole fraction
	Mg	Si	H	C	O		
O_2^+	3E14	5E16	–	–	–	△	–
Cs^+	5E15	5E15	1E17	5E15	2E16	○	○