GaN diodes with high current operations and a low turn-on voltage

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Panasonic Corporation today announced that it developed gallium nitride (GaN) diodes that can not only operate at a high current that is four times greater than that tolerated by conventional silicon carbide (SiC) diodes, but also operate at low voltages by virtue of their low turn-on voltage. Production of the new diodes was made possible via a newly developed hybrid structure composed of of separately embedded structure comprised of a low-voltage unit and a high-current-capable unit, in preparation for high voltage conditions.

Conventional silicon (Si) diodes are limited with regard to reducing switching losses. On the other hand, diodes based on SiC, a compound that is considered as a promising next-generation power semiconductor, as well as GaN, require an increased chip area to achieve high-current operations, thus posing limitations on the reduction of switching losses and size owing to increased operating frequencies.

The newly produced GaN diodes have achieved simultaneous high-current operations and low threshold voltage, and thus can handle high currents even with a small chip area. The capacitance of the chip can therefore be reduced to achieve lower switching losses, allowing the device to operate at higher frequencies. As a result, use of GaN diodes in the voltage conversion circuits or inverter circuits of automotive or industrial equipment that requires high power can reduce system size due to high frequency operation.

This newly developed product has the following advantages.

• High-current operation: 7.6 kA/cm^2 (approximately 4 times)
• Lower turn-on voltage: 0.8 V
• Low on-resistance (RonA):1.3 mΩcm^2 (approximately 50% reduction)

The diodes were created based on the following technologies:

Hybrid structure of GaN diodes with a trenched p-GaN layer:

We proposed a hybrid GaN diode with a p-type layer in which trenches are formed, and developed a processing technology that can remove a p-type layer on an n-type layer in a selective manner to achieve not only high-current operations and a low turn-on voltage but also a breakdown voltage of 1.6 kV.

Fabrication of Diodes on a low-resistance GaN substrate:

For this development, we used conductive GaN substrates with a low resistance, which have been commercially used in LEDs and semiconductor lasers and are expected to be adopted in power devices in the future, and established the technologies for the epitaxial growth and processing on a GaN substrate before forming diodes. A structure in which currents flow in the vertical direction enables a smaller chip area and lower resistance.

Provided by Panasonic Corporation