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AIR WATER

News Release

April 14, 2020
Air Water Inc.

The world's first commercialization-level development of GaN substrates for power transistor based on "SiC on Si substrates"

Air Water Inc. (hereinafter, "Air Water") has developed a GaN substrate for power transistor (hereinafter referred to as "Substrate") in which Nitride composite layers including a GaN transistor layer is grown on the surface of a SiC on Si substrate manufactured by Air Water. Furthermore, Air Water has successfully verified the stability of quality (improved yield) in device production via tests that a device manufacturer/customer of ours conducted on power transistors the manufacturer made on a mass-production line using the Substrate. Currently, efforts are under way to commercialize the product in cooperation with the customer.
This marks the world's first case of a GaN power transistor on a "SiC on Si substrate" reaching the commercialization level.
(Note: GaN: Gallium nitride; SiC: Silicon carbide; Si: Silicon)

1. Overview of GaN power transistors

Power transistors are semiconductor devices used for switching power supplies such as inverters or converters, applications of which cover extensive fields such as the control of inverters in industrial equipment, automobiles, and home appliances, as well as various general-purpose motors.
GaN has attracted attention as a material for next-generation power transistors because of the promises of improved energy saving and enhanced efficiency, and is expected to be widely used in the future, but due to the challenges arising from its cost and performance, GaN power transistors diffusion have been delayed. .

2. Air Water's GaN development history

SiC is widely known as the most suitable material for the growth of GaN film, thanks to its indispensable role in reducing the cost and enhancing the quality of GaN power transistors.
To meet customers' needs in the semiconductor field, Air Water, in the 1980s, started developing "SiC on Si substrate" that could serve as the base of a GaN power transistor as part of industrial gas application technologies. For this purpose, Air Water developed its original and proprietary technology, the Vacuum Chemical Epitaxy (VCE). In 2004, Air Water established basic technology for manufacturing the SiC on Si substrates and, in 2012, Air Water succeeded in developing a mass-production process capable of producing large diameter products of up to 8 inches. At the same time, Air Water built a pilot production plant in Azumino City, Nagano Prefecture, Japan, while continuing to pursue the development of the Substrate featuring a GaN layer grown on a "SiC on Si substrate."

3. Features of the Substrate

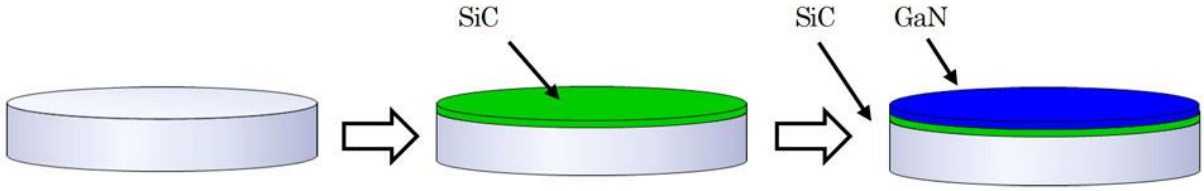
(1) Structure (Refer to the structural illustration as below.)

[1] An inexpensive and commercially available Si substrate can be used.

[2] Forming High-quality SiC film on a Si substrate with Air Water's proprietary growth technology

[3] After the SiC growth processes, a GaN layer (containing nitride-based materials such as AIN (aluminum nitride]) and a transistor layer are grown, at Air Water plant.

Structural illustration of the Substrate, "GaN on SiC on Si substrate"

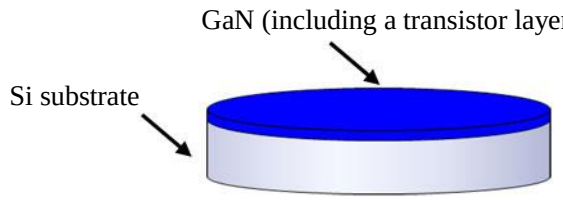


[1] Si substrate (with a diameter of 6 to 8 inches; commercially available)

[2] Epitaxial growth of SiC film

[3] Epitaxial growth of GaN film (including a transistor layer)

Reference illustration for comparison: Method of growing GaN directly on a Si substrate – "GaN on Si substrate"



A GaN layer (containing nitride-based materials such as AIN (aluminum nitride]) and a transistor layer are epitaxially grown directly on the surface of a Si substrate.

(2) Superiority of the Substrate

Since GaN has a higher crystal affinity with SiC than with Si, growing GaN on the surface of SiC improves the crystalline quality of GaN. For this reason, the method described above results in less crystal defects in GaN than when growing GaN directly on a Si substrate. (Refer to the above reference illustration for comparison.)

Furthermore, with less strain in the GaN crystal, the increase in the thickness of a GaN layer does not cause cracks (microscopic or visible crystal cracking) in the crystal.

4. Features of a GaN power transistor based on the Substrate

[1] The decrease in defects in GaN crystals and the dramatic suppression of cracks increase stabilization of the quality (yield) of the customer's power transistor production process.

[2] Increasing the thickness of the GaN layer enables power transistors for power supply to be applied even higher voltages.

[3] The reduced crystal defects in GaN makes possible easy upsizing of power transistors (support for higher currents).

[4] Since SiC has high heat-resistance and heat-conductivity and is an extremely hard material, an improvement in the long-term reliability of power transistors can be expected.

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