Research Groups

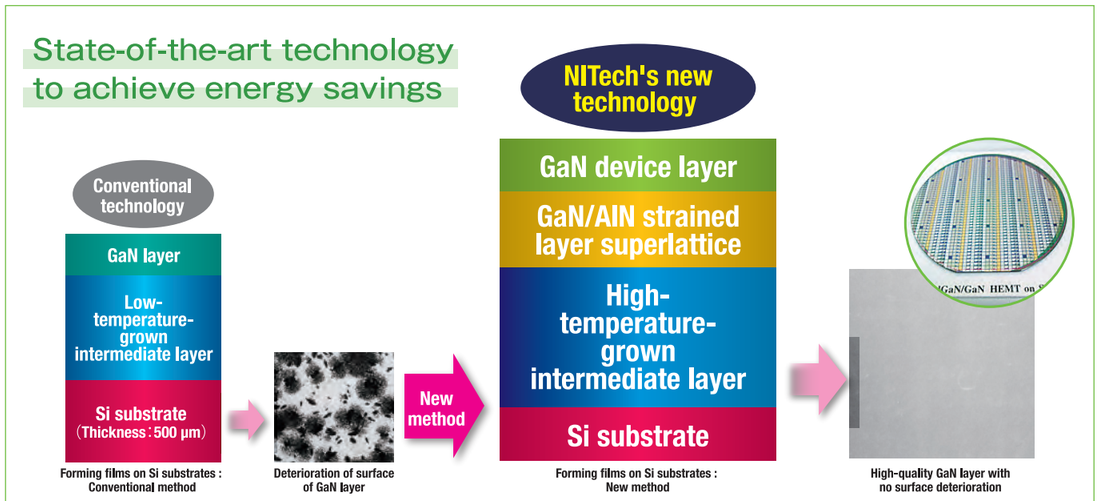
Research group for epitaxial growth and characterization

This group conducts the research into the center's core area: the growth of epitaxial films with GaN electronic device structures on silicon substrates. Nagoya Institute of Technology has been conducting research that has led to new devices for more than 20 years. It has built up an unparalleled portfolio of research and testing, and is using this to develop methods for growing GaN on silicon substrates. The biggest problem with conventional technology has been solved using this new epitaxial growth technology, making it possible to benefit fully from GaN's properties, and broadening the possibilities for high-quality, large-diameter GaN/Si substrates.

We have mass-produced, large-diameter, planetary MOCVD (metal organic chemical vapor deposition) equipment in which six 8-inch silicon substrates can be arrayed simultaneously to grow crystals. Using this equipment, we are creating highly pressure-resistant, uniform GaN electronic device epitaxial wafers, and are conducting research into the conditions related to structure and growth in order to improve the performance further. We are also directing our efforts into the shift to large substrates and mass production technology, so participating companies will be able to conduct research and development using advanced technology and equipment without having to make any new capital investments.

Large-diameter planetary MOCVD equipment

Large XRD measurement system

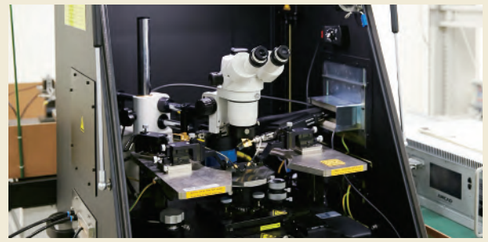


Research group for devices and processing

One of the problems with conventional power electronics technology is thermal losses when energy is converted to electricity. If this can be improved, it will lead to further energy savings and more efficient operation. For example, a general inverter is said to have a thermal efficiency of about 91%. This means 9% of the energy is wasted. Our group is conducting research that aims to achieve GaN power devices that will significantly improve on the conventional thermal efficiency. Improved device efficiency will mean the switching frequency can be increased, enabling capacitors and coils to be made smaller and lighter.

In order to achieve these goals, we have prototyped and evaluated electronic devices using GaN epitaxial films grown on silicon substrates by means of MOCVD. Achieving GaN power devices will require highly pressure-resistant, normally-off operation. In this connection, we are designing and simulating technologies such as recess gate and insulated gate structures, and creating the various processing technologies needed to achieve these structures, and the technologies needed to evaluate them as power devices.

Sputtering system (left), ICP etching system (right)

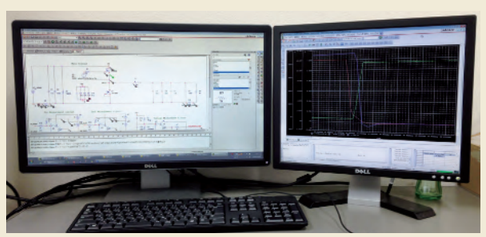


High-speed switching characteristics evaluation system

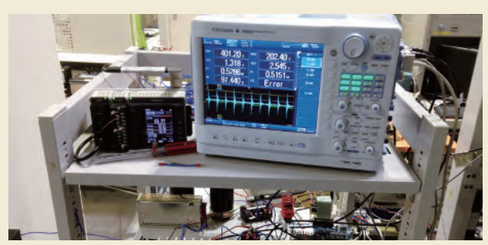
Research group for circuit technology and applications

In order for companies to achieve practical applications for power devices created by using new materials, they will need to pioneer applications that make the devices well worth adopting, and find the optimal ways to apply them. To that end, our group is investigating applications for GaN power devices, and electric control circuits based them. As a concrete example, we are conducting thermal analysis of the design of cooling systems, analysis of the electromagnetic effects that will accompany a shift to high frequencies, and structural analysis regarding thermal stress. In addition, we also design circuits for high-frequency switching with better energy efficiency and energy-saving performance achieved by increasing performance and reducing size, and circuits for power applications to achieve two-way power flow.

We are proceeding with deriving the specifications that will be required for power devices, for example by constructing comprehensive circuit simulators that can thoroughly evaluate losses, EMI, heat, and stresses in power circuits (including the device's dynamic properties). At the same time as determining the specifications, we are also working to brush up these fundamental technologies.



Simulation model for application circuit using GaN/Si devices & simulated voltage and current waveforms of GaN/Si devices



Experimental setup for DC-DC converter employing GaN/Si devices