Summary of the 4th Workshop

University of Tsukuba Forum on Power Electronics Tomorrow (UTOP)

"GaN Power Devices, their Packaging Technology and Applications"

Time & Date: 1:20-5:40pm, February 5, 2016

Venue: Bunkyo School Building, Tokyo Campus, University of Tsukuba

Program:

Mediator: Dai Okamoto, Assistant Professor, Institute of Applied Physics, University of Tsukuba

13:20 "Recent topics at Power Electronics Laboratory, Tsukuba University"
Prof. Noriyuki Iwamuro, Institute of Applied Physics, University of Tsukuba

13:30 "Insulation Property Control of SiO_2 film produced by SiC oxidation"
Kikuo Yamabe, Professor & Takashi Hasunuma, Associated Professor, Institute of Applied Physics, University of Tsukuba

14:20 "Utilization of GaN Power Devices and their Application to PV Power Control System (PCS)"
Kozo Ide, Electrical Development Dep. Environment & Energy Business Drives Div., Yaskawa Electric Corporation

15:10 - 15:25 Coffee break

Mediator: Yuji Yano, Associate Professor, Institute of Applied Physics, University of Tsukuba

15:25 "Mounting Technology for GaN HEMT Power Module "
Ken Shono, Toshihide Yoshikawa & Tsutomu Hosoda, Transform Japan Inc.

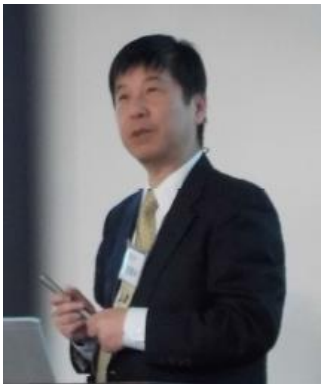
16:15 "GaN Power Device (GIT) Technology"
Yasuhiro Uemoto, Technology Development Center, Semiconductor Business Unit, Panasonic Semiconductor Solutions Co., Ltd.

17:00 Panel Discussion "Aiming for GaN power devices with greater availability"
Mediator: Prof. Hiroshi Tadano, Institute of Applied Physics, University of Tsukuba

17:40 Closing Address

1. Recent topics at Power Electronics Laboratory, University of Tsukuba

Prof. Noriyuki Iwamuro, Institute of Applied Physics, University of Tsukuba



Outline of activities at Power Electronics Laboratory, which was founded in April, 2013, was presented including those as a member of Tsukuba Innovation Arena (TIA) - nano. The laboratory has been expanded steadily and expected to have eight (8) faculty staffs and thirty four (34) students in April, 2016.

The laboratory members have been actively working, including four (4) presentations at the conference of Institute of Electrical Engineers of Japan in last September and five (5) presentations in March, 2016.
The laboratory consists of two donation-based courses and is jointly managed sharing one office room, in which frank discussions can easily take place. Its missions include to produce researchers having multi-specialized domains through these education and research system.

2. Insulation Property Control of SiO_2 film produced by SiC oxidation

Kikuo Yamabe, Professor & Takashi Hasunuma,
Associated Professor, Institute of Applied Physics,
University of Tsukuba

In the oxidation process of the Si crystal, we have developed impurity-free, defect-free and homogeneous SiO_2 film.
In the oxidation process of SiC, oxidant concentration in the proximity of interface between SiC and SiO_2 plays an important role, therefore, its analysis is very principal.
In order to accelerate the technology development of the SiC oxidation process, the following background will be essential:
1) Stable supply of SiC crystal at a reasonable price, 2) Steady SiC crystal growth technology (defect reduction), 3) Researches with broad and widespread approaches, 4) Active information exchange.

3. Utilization of GaN Power Devices and their Application to PV Power Control System

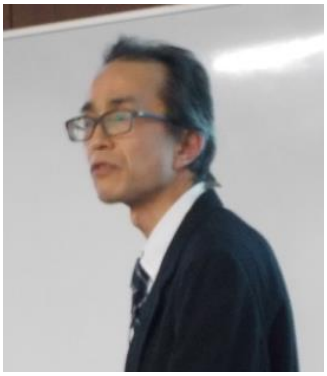
Kozo Ide, Electrical Development Dep. Environment &
Energy Business Drives Div., Yaskawa Electric Corp.

Yasukawa Electric Corporation manufactures and sales power conditioners in its business area of Environment & Energy Division. We added a new power conditioner using GaN device in its lineup in 2015. The new product has advanced features of a low power loss and a high-frequency drive, which leads to a compact product housing. The volume of the product has reduced by 40% caused by power loss reduction of the device and reactor, down-sizing of heat sink.
In comparison with SiC power devices, GaN devices are suitable for a low voltage (600V or less) and a low capacity (100A or less), on the other hand, SiC devices matches with a high voltage (1200V or more) and a high capacity (100A or more). These features will

result in different application products.
In order to expand the application of GaN devices, technological points are
1) Optimization of drive-circuit, and (2 EMC control.

3. Mounting Technology for GaN HEMT Power Module

Ken Shono, Toshihide Yoshikawa & Tsutomu Hosoda,
Transform Japan Inc.



Transform Japan Inc. has a product line-up of three GaN power transistor and one power module.
GaN transistor has a horizontal structure caused by wafer structure of a thin GaN film on the Si base, resulting in the drain location on the surface. On the other hand, SiC device has a vertical structure in which the drain is located on the bottom end of the device.
Power devices possess performance trade-off among withstand voltage, on-time resistance and switching speed. GaN has an advantage of high-speed switching at high frequency. Modularization is preferable in order to take advantage of this feature. GaN module has already commercialized utilizing SiC packaging technology, and achieved high reliability.
The next challenge to be addressed will be making a good balance between performance enhancement and high speed switching.

4. GaN Power Device (GIT) Technology

Yasuhiro Uemoto, Technology Development Center,
Semiconductor Business Unit,
Panasonic Semiconductor Solutions Co., Ltd.

As Si devices are reaching their performance limits, compound-semiconductor power devices receive bigger attention. SiC devices match big capacity and high power application, on the other hand, GaN devices have advantages in smaller and high speed switching equipment.
Three big challenges were conducted for commercialization of GaN devices;
(1) High-quality (low defects) crystal growth on Si wafer, which result in cost reduction,
(2) Normally-off technology (GIT), which leads to safer products
(3) Current collapse control (HD-GIT)

GaN invertors have advantages in no-voltage off-set and a low on-resistance, consequently low loss (η＞99.3%). Power source applications are also effective, such as PFC（Power Factor Correction ； η＝98.7%, 1.2kW Totem-pole PFC）, High-frequency LLC（η＝97.1%, 1kW LLC @320kHz）.

６. Panel Discussion “Aiming for GaN power devices with greater availability”

Prof. Tadano showed comparison table of materials and structures for power devices. Base on the understanding of those differences, panelists discussed on effectiveness of GaN devices, its economic impact, promising systems, problems to be solved and so on.