2013 International Conference on Solid State Devices and Materials

= Short Course C =

Trends for Future Power Devices

September 24, 2013 Hilton Fukuoka Sea Hawk, Fukuoka, Japan

Organizer

Shizuo Fujita (Kyoto University)

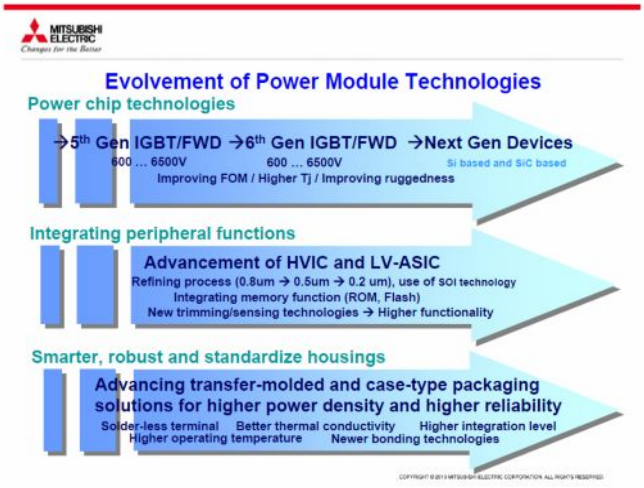
Speakers

13:00-14:00 "Technologies and trends related to Si Power Module"

Dr. Katsumi Satoh (Mitsubishi Electric)

Dr. Tadaharu Minato (Mitsubishi Electric)

The power device with high power capability such as IGBT (Insulated Gate Bipolor Transistor) is a key component in power electronics technology and has progressed more with progress of the application field. This progress has been achieved by the cooperative development between a power chip technology and a package technology. Furthermore, the progress of both an IGBT chip and a diode chip as the key components of the power module has based upon not only the development of its device structure but also the optimized wafer process technology. The Si power chip technologies up to the latest generation for the IGBT power module are explained.



14:00-15:00 "Recent Advances in Si, SiC and GaN High-Voltage Power Devices"

Prof. T. Paul Chow (Rensselaer Polytechnic Institute)

The design methodologies and predicted performance of high voltage SiC and GaN power switching devices will be presented and compared with those of Si counterparts. Recent progress in high voltage Si, SiC and GaN power devices over the last few years will be reviewed. In particular, improvement in Si IGBTs and superjunction MOSFETs will be discussed. Latest demonstrations in SiC Schottky and junction rectifiers, JFETs and MOSFETs, as well as IGBTs and thyristors, will be presented. The performance of lateral and vertical GaN power rectifiers and transistors, together with their monolithic integration and application potentials, will be addressed. The voltage and power ranges within which each technology (Si, GaN or SiC) can be competitive over the others in power device applications will also be projected.

Break (15min.)

15:15-16:15 "Power Electronics Innovation by Widegap Semiconductor Power Devices"

Dr. Hajime Okumura (AIST)

Nowadays, energy saving in electric power is one of the most urgent issues for sustainable development of the human society. Power electronics is a technology for conversion and control of electric power, and believed to be quite promising for electric energy saving. From the viewpoint of power electronics innovation, widegap semiconductors such as SiC and GaN etc. have been recently attracted much attention, because these materials exhibit superior material properties most suitable for high-power switching devices, which are key components of power electronics equipment. For a long time, technological levels of widegap semiconductors has been behind those of conventional semiconductors such as Si and GaAs, due to the difficulty in crystal growth and device fabrication etc. However, remarkable progresses have been achieved in these several years. In this talk, I will briefly introduce the importance of power electronics and related widegap semiconductor technology, including several national projects presently conducted in Japan.

16:15-16:55 "Diamond-Based Power Devices"

Dr. Hitoshi Umezawa (AIST)

Diamond is a promising materials for future electronic devices due to its excellent properties such as high breakdown(>10MV/cm), carrier mobility and thermal conductivity(2200W/mK) and so on. Recent progress and understandings on CVD technique realizes high quality and high rate epitaxial growth with doping controls. Venture companies in Japan and Europe have started to commercialize >1inch single crystalline or hetero epitaxial wafer. In this lecture, the high power diamond devices with >kV and/or high temperature operations will be reported.

Large are wafer techniques will be also introduced.

16:55-17:35 "Gallium Oxide-Based Power Devices"

Dr. Masataka Higashiwaki (NICT)

A new widegap oxide compound semiconductor, gallium oxide (Ga_2O_3), has excellent material properties for power device applications represented by the extremely large breakdown field of 8 MV/cm due to a large band gap of 4.8 eV. Another important advantage of Ga_2O_3 over other widegap semiconductors such as SiC, GaN, and diamond is that large-area single-crystal substrates can be fabricated from a melt-grown bulk crystal, which is high quality, requires neither a high-temperature nor a high-pressure environment, and uses less source material.

Here, after the introduction of Ga_2O_3 material properties and envisioned markets for Ga_2O_3 power devices, I will talk about the current status of R&D on Ga_2O_3 power devices and the future prospects. The experimental results on MESFETs, MOSFETs, and Schottky barrier diodes will be given in the talk as practical examples.