2011 International Conference on Solid State Devices and Materials / 2011 International School on Tokai Region Nanotechnology Manufacturing Cluster =Workshop (1)=

Current status and future prospective of wide gap semiconductor power devices

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Organizers

Hideto Miyake (Mie University)

The power devices with wide bandgap semiconductors such as SiC and GaN are essentially superior to the Si device in the high breakdown electric field and the high-temperature operation. This year will be the first year when the power devices and HEMTs using SiC and GaN would come into practical applications, and the future trends are focused on. This workshop was covered a broad range of areas from the crystal growth of SiC and GaN to their device applications.

Speakers

13:00 Prof. Hiroshi Amano, Nagoya University

“Seeking New Application Fields Using Group III Nitrides”

Majority of the Si-based process technology can be used in fabricating group III nitride based electron devices except for MOVPE technology. Therefore, many people think that group III
nitrides are the successor of the Si-based electron devices. Potential of the group III nitrides are huge, but the performance of the electron devices achieved to date is still in the very preliminary stage. Several approaches to realize ultimate performance nitride-based electron devices will be
shown and the results will be discussed.

13:45 Dr. Tetsu Kachi , Toyota Central R&D Labs., Inc.

“Automotive Applications of GaN Power Devices”

Many high power switching devices are used in an electric vehicle and a hybrid vehicle (EV/HV). For next generation power devices, higher performances than present Si-IGBT are required. GaN is a promising candidate for the requirements. In this presentation, automotive applications and developing GaN power devices are reviewed. The highest electric power module in the EV/HV system is an inverter for main induction motor drive. For the future system, simplifying the cooling system is strongly required. Many middle and low power modules (mainly converters and inverters) are also used. The electric power losses of the used circuits have to be reduced as well as possible. There are two types of developing GaN power devices, which are vertical structure and lateral structure. Vertical structure is suitable for high power applications because high current density is possible. The lateral devices with AlGaN/GaN heterostructure have many advantage for middle and low power applications. The lateral device can operate at high frequency with low on-resistance. This performance make the compact system possible. Automotive applications strongly expect the realization of the high performance power devices.

14:30 Dr. Masahito Kanamura / Dr. Toshihide Kikkawa, Fujitsu Labs. Ltd.

"Recent Progress of GaN HEMT for High Frequency and High Power Applications"(tentative)

15:15 Break

15:30 Prof. Tsunenobu Kimoto, Kyoto University

“Progress and Future Challenges of SiC Power Devices”

High-efficiency electric power conversion is an important technology for energy saving. Silicon carbide (SiC) power devices exhibit high blocking voltage, low on-resistances, and fast switching speed, owing to its superior physical properties.Through recent progress in SiC growth and device technologies, SiC Schottky barrier diodes (SBDs) and power MOSFETs are now commercially available, which contribute to the development of high-efficiency and compact power conversion systems. The size, quality, and cost of SiC wafers have also been remarkably improved. In this presentation, progress and remaining issues of SiC material as well as power devices are reviewed.

16:15 Dr. Jun Kojima / Dr. Kazukuni Hara / Dr. Shoichi Yamauchi / Dr. Shoichi Onda, R&D Partnership for Future Power Electronics Technology Research Laboratories, DENSO CORPORATION

“Development of SiC Single Crystals Growth”

These days, SiC comes close to mass production steps. Qualities and size of SiC wafers have been steadily improved for the last decade. However, the qualities of SiC wafers do not still reach Si level and the cost performance is still insufficient. As our new approaches, we are researching a "high temperature CVD (HTCVD) for bulk growth", instead of a conventional sublimation method.
HTCVD is expected to solve the above issues because it has advantages of gas sources such as high purity source materials, stability of species ratio, flexible controllability and continuous supply of source gases. On the day, we will discuss the potential and the technical issue of HTCVD.

17:00 Dr. Tatsuo Oomori / Dr. Masayuki Imaizumi, Mitsubishi Electric Corporation

“Recent progress of SiC power devices and remaining issues”

Recent remarkable progress of SiC power devices has attracted much attention from power electronics users. R&D of SiC power device technologies with the related application technologies, such as IPMs and power converter systems, is being accelerated to realize widespread systems using SiC power devices.
In this lecture, firstly, we briefly describe the characteristics of power devices required from the point of view of applications. Secondary, the static and dynamic characteristics of unipolar device SiC-MOSFETs and SBDs are presented. Some results relating to their process and reliability are also discussed in this section. Thirdly, we show our results of the inverters equipped with SiC power devices. Then the benefits of SiC power devices for the systems are demonstrated. Finally, we summarize the lecture, and will discuss the remaining issues of SiC power devices.