Nanoelectronic Engineering at MJIIT-UTM

by Engr. Assoc. Prof. Dr Abdul Manaf Hashim

In conjunction with the official commencement of operations of the Malaysia-Japan International Institute of Technology (MJIIT) within the campus of Universiti Teknologi Malaysia in September 2011, nano-engineering has been identified as a leading field to be aggresively pursued with the strong support of top Japanese universities. Fundamental research on emerging materials, novel processes and devices for future "smart electronics" and "green electronics" are the main thrust areas, and the facilities for these are currently under development.

NANOTECHNOLOGY has been identified and declared by the Malaysian government as one of the fields with a high potential for accelerating the national economy. In line with this declaration, the *National Nanotechnology Initiatives of Malaysia* (NNIM) was officially launched by the Deputy Prime Minister on 19 September 2009. The *National Nanotechnology Directorate* based in the Ministry of Science, Technology and Innovation (MOSTI) has been given the responsibility to initiate and accelerate the activities in Nanotechology at the national level so that this field can become as one of the major sources of national income.

Nanotechnology can be defined as the control and manipulation of structures of the size down to atomic scale, and also the process to produce and fabricate the materials and devices in nanoscale for various applications such as information systems, communication systems, sensing systems, energy, etc. (1 nanometer = 1/1,000,000,000 metre or 10^{-9} metre).

Electronic engineering, one of the key areas in the advancement of present engineering and technology, is also not an exception in this evolution towards the so-called nano-engineering. In the 20th Century, the terms "electronic" and "microelectronic" were commonly used. However, in this 21st Century, due to the nature of materials, devices and systems, the terms "nanomaterials", "nanodevices", "nanoelectronics" and "nanosystems" are widely used.

The downsizing of materials and devices to nanoscale has significantly improved the device and system performances, specifically the requirements of high speed, low power consumption, multi-functionality and light-weight features, which have been successfully realised. This is basically due to the shorter transit times of the carriers in the device channels, resulting in less collision frequencies or absolutely no collision while travelling from one terminal to another. The evolution of mobile phone is a good example to understand the contribution of nanoelectronic and nanotechnology to human lives. Due to the remarkable advancement in nanoelectronic engineering, the mobile phones in the market nowadays have a very light-weight form factor equipped with various functions [Figure 1]. This evolution has increased the efficiency and quality of daily work which in turn has affected our lives.

Figure 1: Evolution of the mobile phone

The Malaysia-Japan International Institute of Technology (MJIIT), founded under a government-to-government initiative between the Malaysian government and the Japanese government, officially started its operations in September 2011 at the International Campus of Universiti Teknologi Malaysia (UTM), Kuala Lumpur [Figure 2]. Presently, the Institute is headed by Professor Ir. Megat Johari Megat Mohd Noor as the dean. Although it is governed by the UTM, the education and research systems are designed according to the Japanese systems. This institute is now supported by 23 top Japanese universities to ensure the successful achievement and maintenance of its original vision and mission.

Figure 2: MJIIT building at UTM Kuala Lumpur Campus

Nanoelectronic engineering has been identified by the MJIIT as one of the niche areas, ranging from nanomaterial engineering to nanodevice engineering. This area is to be developed under one specific *kohza*, named as the "Advanced Devices and Materials Engineering Kohza" (*Kohza* is a Japanese term which means "division" and it follows the Japanese pyramid structure). This *kohza* specifically focuses on the fundamental research on emerging materials and devices, ranging from material growth, nanostructure formation, nanofabrication and nanodevices for various applications in nanoelectronic systems, nanophotonic systems, bio-electronic systems, nano-electromechanical systems (NEMS), sensors, solar cell, and so forth.

This *kohza* is founded and headed by the author, and the members are the researchers from various disciplines such as physics, chemistry, biology, electronic engineering and mechanical engineering. The international collaborators are mostly the professors of several Japanese universities such as the Hokkaido University, Kyushu University, Nagoya University and Nagaoka University of Technology. Examples of nano-engineering research carried out by the author's group are briefly shown in Figure 3 to 5. Figure 3 shows the ZnO nanowires grown by thermal evaporation, Figure 4 shows the fabricated graphene nanodevices, and Figure 5 shows the fabricated SiC/Si nanopore.

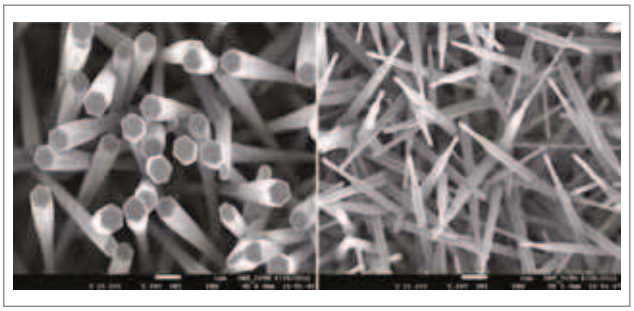

Figure 3: Research on the growth of ZnO nanowires at MJIIT-UTM

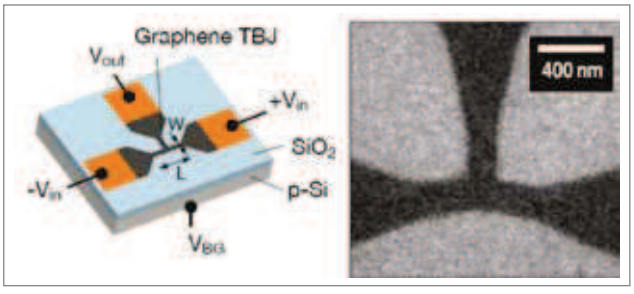

Figure 4: Research on graphene-based nanodevice at MJIIT-UTM (graphene is a one atom-thick layer material)

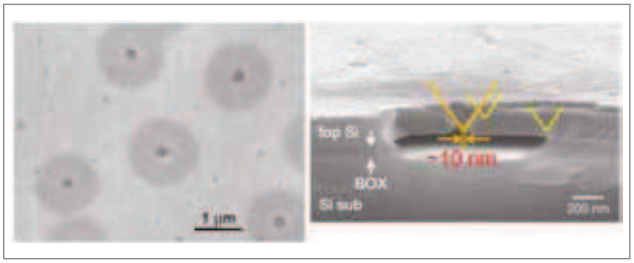

Figure 5: Research on SiC/Si nanopore for DNA sequencing

Currently, the research activities of *kohza* are supported by several major facilities including material growth facilities (CVD system, furnace system, etc.), fabrication facilities (photolithography, etc.) and characterisation facilities (parameter analyser, etc.), and these facilities are placed in the clean room of class 1000 and 10000. Several new facilities such as the reactive ion etching system, PECVD system, electron beam deposition system, and electron beam lithography system will be installed in the current year (2012). It has also been planned to fully facilitate *kohza* with sophisticated and high-tech facilities including electron microscopy systems by the year of 2015 through MJIIT development yen loan grants. These facilities will accelerate the fundamental research activities in nanoscience and nanotechnology, thereby enabling high quality and high impact research to be conducted at MJIIT. ■

Figure 6: Group members of the author's kohza (staff, post-doctoral researchers and post-graduate students)

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