2011 International Conference on Solid State Devices and Materials / 2011 International School on Tokai Region Nanotechnology Manufacturing Cluster
=Short Course (2)=

Fundamentals and applications of carbon nanotube and graphene

September 27, 2011, Nagoya University.

Organizers

Yutaka Ohno (Nagoya University) / Shintaro Sato (AIST)

This short course is intended for students and young researchers who are interested in electronics applications of carbon nanotubes and graphene. The world's leading experts in this field will lecture on their fundamental electronic structure and transport phenomena, growth and characterization techniques, device and conductor applications, together with recent progresses and future aspects. All lectures will be done in English, and all SSDM participants from overseas as well as Japan are welcome.

Plenary Lecture

10:00 Prof. Mitsumasa Koyanagi , Tohoku University , New Industry Creation Hatchery Center

"3D Integration Technology and New Application"

Three-dimensional (3-D) integration technologies are discussed focusing on key technologies such as through-silicon via (TSV), metal microbump, wafer thinning, wafer bonding, wafer alignment and so forth. In addition, a new 3-D integration technology and heterogeneous integration technology based on a reconfigured wafer-to-wafer bonding method called a super-chip integration is described. A number of known good dies (KGDs) with different sizes and different devices are simultaneously aligned and bonded onto lower chips or wafer by a chip self-assembly method using the surface tension of liquid in the super-chip integration. Influences of 3D chip stacking and wafer stacking on device characteristic and reliability are also discussed referring to mechanical stress and Cu contamination induced by Cu-TSVs and metal microbumps. Furtheremore, possibilities for new system-on-a chip and heterogeneous LSIs by 3D integration and super-chip integration such as 3D stacked multicore processor using new shared memory with reconfigurable memory address, 3D stacked dependable processor with self-test and self-repair function, GPU stacked 3D image sensor with extremely fast processing speed, ultra-low power 3D green LSI with energy scavenger devices operated by reusable energy, 3D brain-machine interface (BMI) devices etc. are discussed.

Speakers

12 : 30 Prof. Riichiro Saito, Tohoku University

"Electron and phonon of graphene related materials"

Carbon nanotube and graphene which are known as graphene-related materials have common and unique electronic and phonon properties. In this short course, after introducing the electronic and phonon properties of single wall carbon nanotubes [1] and graphene [2], we discuss the optical properties of graphene related materials such as (1) resonance Raman or Rayleigh spectroscopy, (2) photo-absorption and emission spectra, and (3) coherent phonon spectroscopy. Because of unique electron-phonon and

electron-photon interaction as a function of the wavevector, we can characterize the crystal structure, metalicity, edges, defects, electronic or exciton states. In the case of carbon nanotubes, an electron and a hole bind strongly to each other to form an exciton even at room temperature whose properties are discussed. Finally, we will show that these properties are essential for giving the possible applications of graphene and carbon nanotubes.

13:15 Dr. Kazuhiko Tsukagoshi, MANA, NIMS
"Graphene transport modulated by gate electric field"

14:00 Prof. Hiroki Ago, Kyushu University

"Recent Advances in Growth and Characterization of Graphene and Nanotubes"

Graphene and carbon nanotubes have attracted a great interest because of their unique physical properties and possible applications in many fields, such as composite, energy, and electronics. Electronic applications are one of active fields of graphene/nanotube research because they utilize the outstanding properties of graphene and nanotubes. However, electronic applications require precise control of graphene/nanotube structures, which is accompanied with characterization techniques suitable for graphene and nanotubes.

In this short course, modern growth methods of graphene and carbon nanotubes are reviewed together with their characterization methods. Catalytic chemical vapor deposition (CVD) growth of graphene and nanotubes will be highlighted, because CVD has many advantages such as large-area or large-scale production, direct growth on substrates, and orientation-controlled growth, and . Advanced analysis methods are also reviewed, because the high-level characterization is essential for the controlled growth and applications. Our recent work on graphene/nanotube research, (1) epitaxial CVD growth of single-layer graphene, and (2) horizontally-aligned growth of single-walled carbon nanotubes, will be demonstrated.

14：45 Break

15:00 Prof. Yuji Awano, Keio University
"Carbon Nanotubes for VLSI: Interconnect and Transistor Applications"

15:45 Prof. Jong-Hyun Ahn, Sungkyunkwan University
"Graphene Films for Electronic Applications"