Advance Program

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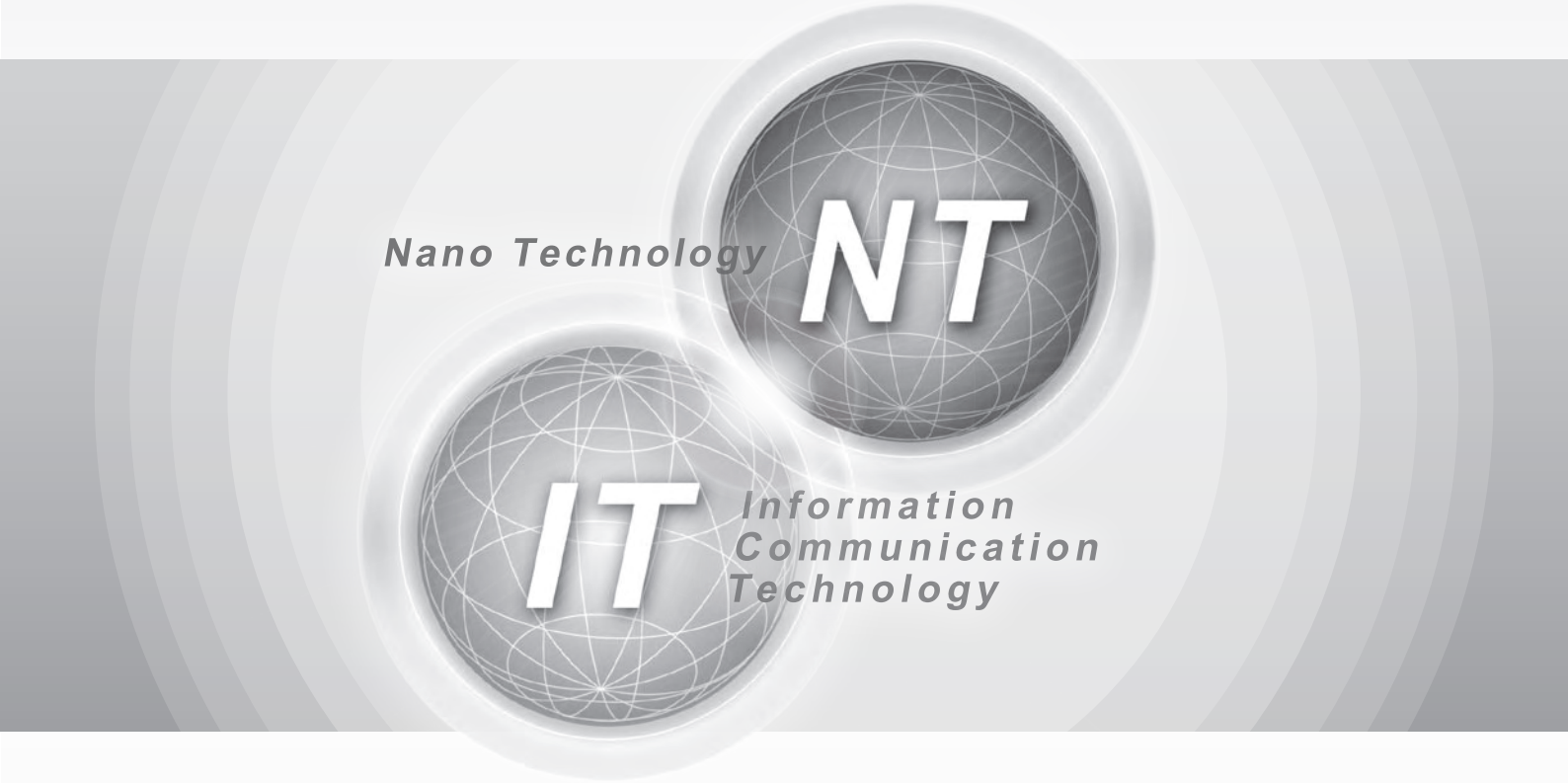


# The 2nd International Symposium on Information Electronics Systems

**July 14-15, 2008**
**Sendai Excel Hotel Tokyu 3F, Sendai, Japan**
***http://www.ecei.tohoku.ac.jp/gcoe/***

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# Program at a Glance

July 14-15, 2008 at Sendai Excel Hotel Tokyu, Sendai, Japan

## Monday, July 14

| | | | |
|---|---|---|---|
| **9:00-9:15** | | **Opening Session** | **Chair: Ryota Miyauchi** |
| | | Opening Remarks | Masataka Nakazawa (Organizing Committee Chair) |
| | | Welcome Address | Fumiyuki Adachi (GCOE Director) |
| | | President's Welcome Greeting | Akihisa Inoue (President, Tohoku University) |
| **9:15-10:30** | **Session 1** | **Nano Technologies 1: Material Evaluation and Characterization** | **Chair: Nobuhiro Kin** |
| 9:15-10:00 | **1-1 (Invited)** | The Secret Life of Ferroelectric Domain Walls | Venkatraman Gopalan (Pennsylvania State University) |
| 10:00-10:15 | **1-2** | Study on Si(111)7×7 Surface Using Non-Contact Scanning Nonlinear Dielectric Microscopy | Yasuo Cho |
| 10:15-10:30 | **1-3** | Homogeneous $TiO_2$-$SiO_2$ Ultra-Low-Expansion Glass for the Extreme Ultra-Violet Lithography System | Jun-ichi Kushibiki |
| **10:30-11:00** | | **Break** | |
| **11:00-12:15** | **Session 2** | **Photonic Devices and Materials** | **Chair: Yasuyoshi Mitsumori** |
| 11:00-11:45 | **2-1 (Invited)** | Recent Progress in Advanced Photonic Crystal Fiber Devices – in a DTU Fotonik Perspective | Anders Bjarklev (Technical University of Denmark) |
| 11:45-12:00 | **2-2** | Development of Entangled Photon Sources | Keiichi Edamatsu |
| 12:00-12:15 | **2-3** | Establishment of High Accuracy Measurement Method of LC Parameters and Surface Alignment Control | Tatsuo Uchida |
| **12:15-13:30** | | **Lunch** | |
| **13:30-14:45** | **Session 3** | **Optical Communication and Networks** | **Chair: Toshihiko Hirooka** |
| 13:30-14:15 | **3-1 (Invited)** | Femtosecond Technology for Optical Arbitrary Waveform Generation | Erich P. Ippen (Massachusetts Institute of Technology) |
| 14:15-14:30 | **3-2** | New Frontiers in Optical Communication: Ultrahigh-Speed Transmission and Coherent Transmission | Masataka Nakazawa |
| 14:30-14:45 | **3-3** | Design of High-Performance Optical Switches | Susumu Horiguchi |
| **14:45-15:15** | | **Break** | |
| **15:15-16:45** | **Session 4** | **Wireless Communication and Networks** | **Chair: Eisuke Kudoh** |
| 15:15-16:00 | **4-1 (Invited)** | Enhancing the Social Web through Augmented Social Cognition Research | Ed Chi (PARC) |
| 16:00-16:15 | **4-2** | Broadband Wireless Distributed Signal Processing and Network Technology | Fumiyuki Adachi |
| 16:15-16:30 | **4-3** | Efficient Method of Moments for Large-Scale Periodic Array Antennas | Kunio Sawaya |
| 16:30-16:45 | **4-4** | A New Data Gathering Scheme Based on Set Covering Technique for Mobile Sinks in WSNs | Nei Kato |
| **16:45-18:00** | | **Poster Session** | **Ball B** |
| **18:00-20:00** | | **Banquet** | **Ball A** |

## Tuesday, July 15

| | | | |
|---|---|---|---|
| **9:00-10:30** | **Session 5** | **Nano Technologies 2: New Materials and Processing** | **Chair: Toshiro Kaneko** |
| 9:00-9:45 | **5-1 (Invited)** | Novel Architectures for Nanoelectronics with Carbon Nanotubes, Quantum Dots and Photonic Crystals | Anvar Zakhidov (University of Texas at Dallas) |
| 9:45-10:00 | **5-2** | Nanodevice-Oriented Nanoscopic Plasma Procoss Control | Rikizo Hatakeyama |
| 10:00-10:15 | **5-3** | Fabrication of Anodic Titanium Nanotubes Used for Dye-Sensitized Solar Cells | Michio Niwano |
| 10:15-10:30 | **5-4** | Atomically Controlled Processing for Future Si-Based Devices | Jun-ichi Murota |
| **10:30-11:00** | | **Break** | |
| **11:00-12:30** | **Session 6** | **Magnetics and Spintronics** | **Chair: S. J. Greeves** |
| 11:00-11:45 | **6-1 (Invited)** | Ferrofluids: Magnetic Liquids | Kevin O'Grady (University of York) |
| 11:45-12:00 | **6-2** | Perpendicular Magnetic Recording and Its Extension for High Density Data Storage Technologies | Hiroaki Muraoka |
| 12:00-12:15 | **6-3** | Tailor-Made Nano Structured Material for Highly Qualified Spin Related Devices | Migaku Takahashi |
| 12:15-12:30 | **6-4** | Control of Spins in Semiconductor Structures | Hideo Ohno |
| **12:30-13:30** | | **Lunch** | |
| **13:30-15:15** | **Session 7** | **Intelligient Signal Processing and Multimedia Communication Technologies** | **Chair: Naofumi Homma** |
| 13:30-14:15 | **7-1 (Invited)** | Quo Vadis Nanoarchitectures? | Valeriu Beiu (United Arab Emirates University) |
| 14:15-14:30 | **7-2** | Fine-Grained Low-Power Reconfigurable VLSI for Real-World Applications | Michitaka Kameyama |
| 14:30-14:45 | **7-3** | Novel-Device-Based Circuit Architecture for New-Paradigm VLSI Computation | Takahiro Hanyu |
| 14:45-15:00 | **7-4** | High-Accuracy Machine Vision Technology Using Phase-Only Correlation | Takafumi Aoki |
| 15:00-15:15 | **7-5** | Realization of Advanced Acoustic and Multi-Modal Information Systems | Yôiti Suzuki |
| **15:15-15:45** | | **Break** | |
| **15:45-16:45** | **Session 8** | **Computing and Algorithm** | **Chair: Jinhee Chun** |
| 15:45-16:00 | **8-1** | TyPiCal: A Type-Based Analyzer for the Pi-Calculus | Naoki Kobayashi |
| 16:00-16:15 | **8-2** | Consistent Digital Rays | Takeshi Tokuyama |
| 16:15-16:30 | **8-3** | Optimal Realizations of State-Space Digital Filters | Masayuki Kawamata |
| 16:30-16:45 | **8-4** | Probabilistic Information Processing and Bayesian Networks | Kazuyuki Tanaka |
| **16:45-16:50** | | **Closing Session** | **Ball A** |
| | | Closing Remarks | Masataka Nakazawa (Organizing Committee Chair) |

9:00 Opening Session

## Nano Technologies 1: Material Evaluation and Characterization

9:15 1-1 **The Secret Life of Ferroelectric Domain Walls (Invited)**

**Venkatraman Gopalan, Pensylvania State University, USA**

This talk will discuss several surprising aspects of ferroic domain walls.

The first aspect is that unlike ideal antiparallel walls that are only 0.5nm wide, walls in real materials can surprisingly extend to tens of nanometer scale, arising from interactions with organized point defects and surfaces. Further, phase-field modeling shows that the threshold fields for moving this wall dramatically drops by 2-3 orders of magnitude if the wall were diffuse by only ~2-3nm, bringing the theoretical and experimental threshold fields in agreement. Atomistic and phase-field modeling sheds light on the nature of these organized defects and their interaction with the wall and surfaces.

I will also discuss a second surprising aspect of ferroelectric and ferroelastic domain walls that is not widely appreciated, namely, the presence of magnetic symmetry to pure lattice distortion, and Bloch-like and Neel-like character to ferroelectric walls in non-magnetic materials.

10:00 1-2 **Study on Si(111)7×7 Surface Using Non-Contact Scanning Nonlinear Dielectric Microscopy**

**Yasuo Cho, RIEC, Tohoku University**

A local atomic electric dipole moment distribution of Si atoms on Si (111)7×7 surface is clearly resolved by using a new technique called non-contact scanning nonlinear dielectric microscopy. The dc-bias voltage dependence of the Si atom on Si(111)7×7 surface is measured. At the weak applied voltage of -0.5 V, positive dipole moment is detected on the Si adatom sites, whereas a negative dipole moment is observed at the interstitial sites of inter Si adatoms. Moreover, the quantitative dependences of surface dipole moment as functions of applied dc bias voltage are also revealed at a fixed point above the sample surface. This is the first successful demonstration of atomic resolution achieved in the field of capacitance measurement.

10:15 1-3 **Homogeneous $TiO_2$-$SiO_2$ Ultra-Low-Expansion Glass for the Extreme Ultra-Violet Lithography System Evaluated by the Line-Focus-Beam Ultrasonic Material Characterization System**

**Jun-ichi Kushibiki, Tohoku University**

Development of extremely homogeneous $TiO_2$-$SiO_2$ ultra-low-expansion glass is a very important issue for next-generation extreme ultraviolet lithography (EUVL). The characteristics of coefficient of thermal expansion (CTE) can be controlled by the $TiO_2$ concentration around 7 wt%. Conventional techniques of analyzing CTE characteristics did not have sufficient measurement accuracy and were not suitable for surface characterization, so we proposed and demonstrated our ultrasonic method using the line-focus-beam ultrasonic material characterization (LFB-UMC) system by measuring the phase velocity of leaky surface acoustic waves propagating on a water-loaded specimen surface. This technique allows nondestructive and noncontact two-dimensional analysis and evaluation of the CTE characteristics of EUVL glass with much higher accuracy. In this paper, we conduct a trial production of a $TiO_2$-$SiO_2$ ultra- low-expansion glass by the soot method and its homogenization by the zone-melting method. We evaluate elastic homogeneities of the glass with dimensions of about 245 mm × 100 mm × 100 $mm^t$ by the LFB-UMC system at 225 MHz. We observe the homogeneous velocity distribution mostly within ±1.13m/s, corresponding to the CTE variation of ±5 ppb/K with no striae.

10:30-11:00 Coffee Break

# Session 2（Ball A）Monday, July 14th, 11:00-12:15

## Photonic Devices and Materials

11:00 2-1

### Recent Progress in Advanced Photonic Crystal Fiber Devices – in a DTU Fotonik Perspective (Invited)

**Anders Bjarklev, Technical University of Denmark, Denmark**

Photonic crystal fibers have over the past decade turned from a topic of intense research to become a key technology in advanced optical products. Today the research continues through development of highly advanced fibers that combines light guiding through bandgap and modified total internal reflection mechanisms, and which handle a broad variety of different optical modes and polarization states. The fibers make use of a wide selection of materials ranging from the more traditional combinations of air-filled solids to devices with liquid filled channels. Among these, liquid crystal photonic bandgap fibers represent a promising platform for the design of all-in-fiber optical devices. These devices show a high degree of tunability and exhibit novel optical properties that allow manipulation of guided light. Here we present tunable fiber devices for spectral filtering, such as Gaussian filters and notch filters, and devices for polarization control and analysis, such as birefringence control devices and switchable and rotatable polarizers. We will further report on the fabrication of novel hollow-core and all-solid fibers that show high birefringence and possess accurately controlled dispersion characteristics.

11:45 2-2

### Development of Entangled Photon Sources

**Keiichi Edamatsu, RIEC, Tohoku University**

Entanglement is one of the key resources for quantum information and communication protocols. Photons are the most versatile medium to generate, transfer, and process the entanglement. We present our activity of developing efficient sources of entangled photons, by use of quasi-phase-matched nonlinear optical crystals and semiconductor materials.

12:00 2-3

### Establishment of High Accuracy Measurement Method of LC Parameters and Surface Alignment Control for High Performance Liquid Crystal Device

**Tatsuo Uchida, Tohoku Unicersity**

To realize high performance liquid crystal devices, the material and device parameters of liquid crystals and control of the surface alignment are important. Two methods based on ellipsometry are newly proposed to measure the parameters. They are multiple interference tri-incidence (MITI) method and multi-angle incident with voltage application (MAIV) method. The MITI method is used to measure two refractive indices of liquid crystal, the cell gap and the pretilt angles of the homogeneously aligned cell in high accuracy. The MAVI method is used to measure surface anchoring strength and capacitance of the alignment layer, which have been difficult to measure until now. By using these two methods and conventional methods, almost all of the parameters to design high quality electro-optical liquid crystal devices can be obtained finally. To add special characteristics on the liquid crystal devices, measuring and controlling the surface order parameter quantitatively are also important. The phase transition droplet method proposed by us is adopted for a measurement. The alignment condition is changed experimentally and the relation between the process condition and the surface order parameter is clarified. From this result, the physics of the surface phenomena are partially clarified and the fundamental control of the order parameter is established as a first step.

12:15-13:30 Lunch Break

# Session 3（Ball A）Monday, July 14th, 13:30-14:45

## Optical Communication and Networks

13:30 3-1

### Femtosecond Technology for Optical Arbitrary Waveform Generation (Invited)

**Erich P. Ippen, Massachusetts Institute of Technology, USA**

Strategy and progress towards the generation of optical arbitrary waveforms based on femtosecond laser frequency combs will be discussed. With octave-spanning spectra a laser's optical frequencies are locked to multiples of its repetition rate and then further to a compact methane-stabilized HeNe frequency reference. The goal is to achieve this with the 10 GHz comb frequency spacing needed to demultiplex the individual comb lines in an integrated photonic circuit so that each line can be modulated independently at the laser repetition rate. Recent results obtained with both Ti:sapphire and fiber laser systems will be presented. Together these systems promise to provide referenced and stabilized frequency combs extending from 500nm to 2μm.

14:15 3-2

### New Frontiers in Optical Communication: Ultrahigh-Speed Transmission and Coherent Transmission

**Masataka Nakazawa, RIEC, Tohoku University**

I present our recent progress on ultrahigh-speed transmission and coherent optical transmission, which are two emerging fields in optical communication. As regards ultrahigh-speed OTDM transmission, I will describe a 160 Gbit/s DPSK transmission that uses time-domain optical Fourier transformation (OFT), in which the transmission distance is extended to 1,000 km by eliminating transmission impairments caused by jitter and the dispersion slope. Furthermore, the transmission speed was increased to 320 Gbit/s, and an error- free transmission over 525 km was successfully achieved with a large tolerance to higher-order PMD. As regards coherent transmission, I will describe a 1 Gsymbol/s, 128 quadrature amplitude modulation (QAM) coherent optical transmission over 160 km. The QAM data multiplication level was successfully increased to 128 by improving the modulation characteristics of the IQ modulator and the PLL circuit for the IF frequency. Here, 14 Gbit/s data were transmitted in an optical bandwidth of only 1.4 GHz as a result of bandwidth reduction by adopting a Nyquist filter combined with polarization multiplexing. These technologies are expected to open a new era in which we will achieve a spectral efficiency of > 10 bit/s/Hz.

14:30 3-3

### Design of High-Performance Optical Switches

**Susumu Horiguchi, Tohoku Unicersity**

Although the electronic switches are mature and easy to implement, their capacity growth is historically slower than the growth of optical link capacity. This is why switches/routers have increasingly become a bottleneck for Internet communications. A natural choice (also seems to be the only one) is to use all-optical switches. Adopting optical switches can not only achieve over 100 Tbit/s or even Pbit/s throughputs, but also dramatically reduce the power consumption, eliminate the high cost O/E/O conversions and thus make the switching operation independent of bit-rate and protocol. In this paper, we introduce our recent research activity on the design of high-performance optical switches, in particular the Directional Coupler (DC)-based optical switches and the Arrayed Waveguide Grating (AWG)-based optical switches.

14:45-15:15 Coffee Break

## Wireless Communication and Networks

15:15 4-1

### Enhancing the Social Web through Augmented Social Cognition Research (Invited)

**Ed Chi, Palo Alto Research Center (PARC), USA**

We are experiencing the new Social Web, where people share, communicate, commiserate, and conflict with each other. As evidenced by Wikipedia and del.icio.us, Web 2.0 environments are turning people into social information foragers and sharers. Users interact to resolve conflicts and jointly make sense of topic areas from "Obama vs. Clinton" to "Islam."
PARC's Augmented Social Cognition researchers -- who come from cognitive psychology, computer science, HCI, sociology, and other disciplines -- focus on understanding how to "enhance a group of people's ability to remember, think, and reason". Through Web 2.0 systems like social tagging, blogs, Wikis, and more, we can finally study, in detail, these types of enhancements on a very large scale.
In this talk, we summarize recent PARC work and early findings on: (1) how conflict and coordination have played out in Wikipedia, and how social transparency might affect reader trust; (2) how decreasing interaction costs might change participation in social tagging systems; and (3) how computation can help organize user-generated content and metadata.

16:00 4-2

### Broadband Wireless Distributed Signal Processing and Network Technology

**Fumiyuki Adachi, Tohoku University**

In the next generation wireless networks, a variety of broadband data services of 100M~1Gbps is demanded. However, for such a high rate data transmission, wireless channels become severely frequency- selective and are power-limited. To solve the above problems, we have been taking two approaches: distributed antenna network (DAN) and virtual cellular network (VCN). In DAN, each base station which is a gate way to the core network has spatially distributed multiple antennas and serves a user using frequency-domain multi-input/multi- output (MIMO) antenna diversity technique. For improving the down- link (base-to-mobile) transmission performance, we proposed a new space-time block-coded MIMO antenna diversity that can use an arbitrary number of distributed transmit antennas while limiting the maximum number of receive antennas to 4. In VCN, on the other hand, many relay stations are distributed in an area covered by each base station and user's signal is relayed to a base station with the aid of wireless multi-hop technique. Assuming 2-hop OFDMA VCN, we have proposed a distributed channel allocation scheme based on the maximization of the signal-to-interference plus noise power ratio (SINR) of each multi-hop link and a routing algorithm based on the total propagation loss minimization criterion.

16:15 4-3

### Efficient Method of Moments for Large-Scale Periodic Array Antennas

**Kunio Sawaya, Tohoku University**

Method of moments (MoM) is a powerful technique for numerical analysis of characteristics of antennas and has been widely used. However, CPU time and memory size required for MoM analysis are proportional to $N^3$ and $N^2$, respectively, where $N$ is the number of unknown coefficients and is several times of the number of elements of array antenna, and MoM can not be applied to a large-scale array antennas. In order to overcome this limitation, fast and efficient MoM using conjugate-gradient (CG) method and fast Fourier transform (FFT) is proposed. Equivalent sub-array preconditioner is also proposed to reduce the iterative steps significantly. Proposed algorithm has a great advantage that the CPU time can be much reduced by using supercomputer. Numerical analysis of a large scale dipole array antenna having 256×256 elements is performed showing the validity and advantages of the proposed method.

16:30 4-4

## A New Data Gathering Scheme Based on Set Covering Technique for Mobile Sinks in WSNs

**Nei Kato, Tohoku University**

Recent advances in solid state and packaging technologies have enabled production of more efficient and reasonable small devices such as Micro Electro Mechanical Systems (MEMS). Wireless Sensor Networks (WSNs) can gather data, which we could not gather before, such as the detailed temperature data from wide area, and are now at the practical stage of realizations because of the above advances. Conventional researches in WSNs have mainly focused on extending the lifetime of the network because sensor nodes are only equipped with small-capacity batteries, and we cannot exchange or recharge them generally. Mobile Ubiquitous LAN Extension (MULE) can greatly extend the lifetime and can gather data from even isolated nodes, and KAT mobility is one of the methods using the MULE. By applying the KAT mobility scheme, we can gather data from nodes efficiently, and it is expected that this scheme can prolong the lifetime of the network. However, this scheme cannot ensure that the mobile sink can gather the data from all of the nodes. In this paper, we proposed a new mobility scheme based on set covering technique, and we focus on the fairness issue of data gathering by using Fairness Index, considering the efficiency of data gathering.

16:45-18:00 Poster Session (Ball B)

18:00-20:00 Banquet (Ball A)

## Nano Technologies 2: New Materials and Processing

9:00 5-1

### Novel Architectures for Nanoelectronics with Carbon Nanotubes, Quantum Dots and Photonic Crystals (Invited)

**Anvar Zakhidov, University of Texas at Dallas, USA**

One of the most important outcomes of nanotechnology (NT) for benefits of information technology (IT) is the emergence of new classes of novel functional nanomaterials: such as carbon nanotubes (CNT), quantum dots (QD), photonic crystals (PC), negative index metamaterials (NIM), etc., which will be used for future IT hardware. This nanomaterials enable new architectures for nanoelectronic devices of IT, making them smaller, higher efficiency, flexible, faster and bringing to game a whole spectrum of new functionalities, which are not possible with conventional materials, such as Si. In this talk I will review some new applications of CNTs, QDs and PCs which become possible due to progress with their synthesis and processing and with new design for device architectures.

CNTs are great material of NT and several applications are already developed [1], however inability to assemble CNTs into macroscopic self-sustained structures was limiting their use in IT. We have developed a new process which allows to create multiwall CNT-based sheets and yarns that are strong free-standing materials [2] with exceptional mechanical strength, and can be produced with practically unlimited length and widths. Recently we demonstrated that transparent films of CNT can be been used as 3-dimensional charge collectors and injectors for various devices: in plastic organic photovoltaic (OPV) solar cells [3], in organic light emitting (OLED) displays [2,5] and in electron field emitters for displays [4].

Dye sensitized solar cells (DSC) are another type of energy conversion device of interest for IT due to their high efficiency and low cost. Presently used Pt coated ITO counter-electrode in DSC can not be applied in flexible DSC architectures. In a talk we show that the transparent sheets of SWCNT/MWCNT perform as a flexible anode and as electrochemical catalyst and also can be used in new types of hybrid tandems of DSC with OPVs cells as transparent interconnect layer. We also discuss how CNT sheets can be used in thin flexible and bright OLED displays as charge injectors with efficient field emission mechanism [4].

QDs hold a great promise as nanomaterial which can significantly increase the efficiency of solar cells due to recently discovered process of carrier multiplication (CM). We will describe new architectures, which are needed to make this CM effect work in devices, on the example of our recent work on QD-based hybrid OPV [6].

We have created synthetic opals and inverted opals as functional 3-dimensional PCs, and I will show how new phenomena of negative refraction of light takes place in opals and studied by imaging of QDs in opals and can be used for OLEDs and other IT devices.

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9:45 5-2

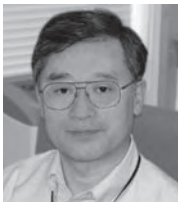
## Nanodevice-Oriented Nanoscopic Plasma Procoss Control

**Rikizo Hatakeyama, Tohoku University**

The nanoscopic plasma process control has been performed in order to contribute to the foundation establishment of nano information- electronics with a nanocarbon network consisting of graphenes, fullerenes, carbon nanotubes, biomolecule DNA, colloids, and ionic liquids. Here, by especially taking up $C_{60}$, SWNTs(single-walled carbon nanotubes), and DWNTs(double-walled carbon nantubes), systematic experiments are carried out in series on the synthesis of unprecedented atom-encapsulated $C_{60}$, individually free-standing growth of SWNTs, creaton of encapsulated SWNTs and DWNTs with injection of various kinds of atoms and molecules, their characterization, and device measuremens. Some results worthy of special mention are achievement of the highest synthesis purity 0.08 % of atomic-nitrogen encapsulated $C_{60}$ ($N@C_{60}$), clarification of SWNTs growth mechanim, finding of unusually localized electronic structure inside Cs@SWNT, realization of nano pn junctions with $(Cs/C_{60})$@SWNTs, $(Cs/C_{60})$@DWNTs, (Cs/I)@SWNTs and (Cs/I)@DWNTs, and finding of distinct negative differential resistance with $C_{60}$@DWNTs, $C_{70}$@DWNTs and $C_{84}$@ DWNTs, and observation of photoinduced electron transfer phenomena in $C_{60}$@SWNTs and DNA @ or decorated SWNTs.

10:00 5-3

## Fabrication of Anodic Titanium Nanotubes Used for Dye-Sensitized Solar Cells



**Michio Niwano, RIEC, Tohoku University**

Dye-sensitized solar cells (DSSCs) have been extensively studied because of the simple structure and the relatively high energy conversion efficiency comparable to that of amorphous silicon solar cells. In DSSCs, titanium oxide ($TiO_2$) powder is widely used as the negative electrode. In order to obtain higher energy conversion efficiency, it is important to develop titanium oxide electrode having a high electrical conductivity and a huge surface area to adsorb many dye molecules. In the $TiO_2$-powder electrode, electrons most likely scatter at grain boundaries. The scattering of electron reduces the conductivity of the electrode, resulting in a decrease in the energy conversion efficiency. $TiO_2$ nanotube is a promising material as used for the negative electrode since it has less grain boundaries and a huge surface area. For applying anodic $TiO_2$ nanotubes to the negative electrode of DSSCs, it is necessary to improve the growth rate and to control the structure such as the pore diameter with high aspect ratio. In this study, we demonstrate that long $TiO_2$ nanotubes of more than 10 in length can be synthesized in a few minutes by anodization. Anodic $TiO_2$ nanotubes thus synthesized are used as the negative electrode of DSSCs.

10:15 5-4

## Atomically Controlled Processing for Future Si-Based Devices

**Jun-ichi Murota, RIEC, Tohoku University**

Atomically controlled processing has become indispensable for the fabrication of Si-based ultrasmall devices, because high performance devices require atomic-order abrupt heterointerfaces and doping profiles. Our concept of atomically controlled processing for group IV semiconductors is based on atomic-order surface reaction control. By the Si epitaxial growth over the material already- formed on Si(100) at growth temperatures below 500°C, atomic-layer doping of a half atomic layer of N, P, B is achieved. In their structures, N and B atoms are confined within about 1 nm thick layer, which is nearly the same as the measurement accuracy. N atoms in $Si_{1-x}Ge_x$ are preferably combined with Si atoms. In the P atomic-layer doping, segregation of P atoms during the Si epitaxial growth is suppressed by using $Si_2H_6$ instead of $SiH_4$ at low temperature of 450°C. Atomic-layer doping results indicate that very high carrier concentration and higher carrier mobility are achieved compared with doping under equilibrium conditions. By the strain control of the $Si/Si_{1-x}Ge_x/Si(100)$ heterostructure due to striped patterning, it is confirmed that the tensile strain induces mobility enhancement for both electron and hole in group IV semiconductors. These results demonstrate the capability of the atomically controlled processing approach for future Si-based devices.

10:30-11:00 Coffee Break

## Magnetics and Spintronics

11:00 6-1 **Ferrofluids: Magnetic Liquids (Invited)**

**Kevin O'Grady, University of York, UK**

Magnetic liquids in the form of colloidal dispersions have been known since the 1060s. They have found application in a number of areas principally forming seals in vacuum rotary feedthroughs, damping materials in loudspeakers, magnetic sink float separators and in a range of other niche applications. This lecture will describe the physics of these materials including methods by which they are prepared and aspects of their magnetic behaviour that lead to the applications. All the applications listed above will be described in detail and demonstrated during the lecture via a series of "hands-on" experiments.

All other liquids on earth are subject only to normal gravitational forces whereas a ferrofluid behaving as a true magnetic liquid, can also have its normal physical behaviour affected by a magnetic field which is divergent. Hence ferrofluids exhibit a number of highly unusual and unexpected phenomena. These phenomena will also be demonstrated during the lecture. Finally possible future applications will be discussed particularly those in the sphere of biomedical opportunities.

11:45 6-2 **Perpendicular Magnetic Recording and Its Extension for High Density Data Storage Technologies**

**Hiroaki Muraoka, RIEC, Tohoku University**

Areal density of hard disk drives is quickly growing. The target density is 1 Tbits/inch$^2$ and beyond, where one bit corresponds to a square of only 25.4 nm on a side or less. This certainly is a good example of nano-technology, and extremely high areal density greater than any other information storage devices. From this viewpoint, technology outline of high density magnetic recording is provided. A recent topic was the introduction of perpendicular magnetic recording. This talk focuses on perpendicular magnetic recording, in particular, recording theories and head/media technologies. The recording layer of the media consists of nano-sized magnetically isolated grains. This 'granular' structure was essential. However, since the areal density was limited by thermal instability of recorded magnetization, which is governed by this granular nature, a novel extension for perpendicular magnetic recording is keenly explored for the terabit density technology. A recording concept of 'bit patterned media', in which each bit is artificially fabricated by lithographic means, is discussing as a crucial candidate technology. Because each bit of the patterned media has a tightly coupled exchange-coupling inside, its recording scheme is totally different to the conventional granular one. A recording theory for this media is therefore discussed.

12:00 6-3 **Tailor-Made Nano Structured Material for Highly Qualified Spin Related Devices**

**Migaku Takahashi, NICHe, Tohoku University**

Highly qualified spin related devices such as ultra-high density hard disk drive (HDD) and magnetic random access memory (MRAM), inductor and antenna for high frequency use are inevitable requirements for recent IT technology. Tailor-made spin nano structured materials by precisely controlled fabrication technology with nano-scale in each devices and understanding their nanomagnetics are essential from the view point of material, process, and physics. Artificial control of the exchange coupling among ferromagnetic layers through the RKKY interaction (indirect) and the direct exchange coupling represented as the exchange bias at the ferromagnetic(FM)/ antiferromagnetic(AFM) interface are paid hot attention to induce newly modulated spin structures in conventional simple ferromagnetic material. Especially, Exchange Coupled Composite (ECC) media introducing the exchange coupling between ferromagnetic layers and the giant exchange anisotropy at FM/AFM interface have been attracted much attention from the view point of real applications. High frequency response in GHz range using conventional metallic ferromagnetic material has a frequency limit determined by Snoek's law. To overcome this physical limit, we newly proposed magnetic- dielectric material consisting of magnetic nanoparticle assembly, which shows superparamagnetic response, with polymer hybridization for possible application to the high-frequency devices. Within the frame work of the present paper, correlation between tailor-made nano structured material and magnetic properties developed for each categorized research items mentioned above will be widely discussed in connection with spin related devices.

12:15 6-4 **Control of Spins in Semiconductor Structures**

**Hideo Ohno, RIEC, Tohoku University**

We are working on the control of the spin states in semiconductor structures, where localized magnetic spins, itinerant electron spins, nuclear spins are of our interest. In this work we focus mainly on the domain wall dynamics in a ferromagnetic semiconductor (Ga,Mn)As. We have demonstrated the current-induced domain wall (DW) motion and succeeded to clarify its mechanism. By comparing the DW velocity as a function of current density and temperature with theoretical model, we discuss the effect on spin current on DW above and below threshold current density. In a nonmagnetic quantum structure, we have observed successfully the artificial atomic properties and evaluated the g value in a narrow-gap semiconductor (In,Ga)As quantum dot with MIS-gate and air- bridge drain structures.

12:30-13:30 Lunch Break

# Session 7 （Ball A） Tuesday, July 15th, 13:30-15:15

## Intelligient Signal Processing and Multimedia Communication Technologies

13:30 7-1

### Quo Vadis Nanoarchitectures? (Invited)

**Valeriu Beiu, United Arab Emirates University, UAE**

This presentation will introduce the many challenges facing the design of future tera-scale integrated circuits -- that result in fact from the restless scaling of nano-electronic devices towards the infinitesimal. The relations among these challenges will be studied, and a relative ranking will be proposed. Afterwards, we shall delve into the three most difficult challenges: power, reliability, and communication. We shall present very fresh reliability studies that take into account not only the probabilities of failure of the elementary gates, but -- much more importantly – the probability of failure of the (nano-)devices, as well as that of their associated interconnects. Several defect- and fault-tolerant designs -- specifically targeting nano-scale devices -- will be introduced and analyzed. Finally, IC and Brain communication will be both used as examples bridging the reliability and the power challenges. All of these will aim at revealing how the Brain is able to optimizing information processing, while drastically minimizing energy, even when using highly unreliable computation devices and communication channels.

14:15 7-2

### Fine-Grained Low-Power Reconfigurable VLSI for Real-World Applications

**Michitaka Kameyama, Tohoku University**

Nowadays, reconfigurable VLSIs such as Field-programmable gate arrays (FPGAs) are widely used to implement special-purpose processors. They are cost-effective for small-lot production and flexible because functions and interconnections can be modified by end users after fabrication. Despite their design cost advantage, FPGAs impose large power consumption overhead compared to custom silicon alternatives. To overcome the overhead, we propose novel architectures for field- programmable VLSIs (FPVLSIs). A low-power FPVLSI is proposed based on a fine-grained supply-voltage-control scheme. Dual supply voltages are used to reduce the power consumption without performance degradation. The low supply voltage is applied to cells for non-critical-path operations to reduce power consumption. Its major issue is the area and power overhead of level converters. To solve this problem, dynamic circuits are used to design a level- converter-less look-up table. An asynchronous FPVLSI is also proposed to reduce power consumption due to clock distribution that occupies more than 30% of the total power consumption. To ensure the correct operation independent of data-path lengths, we use the level-encoded dual-rail encoding and propose its area-efficient implementation. To make dynamic reconfiguration with low power, a fine-grained architecture for a multi-context FPVLSI is proposed that provides more cost-effective implementations than FPGAs where hardware resources are dedicated to a single context. The major drawback of the MC-FPVLSI is the large memory capacity for multiple contexts. To overcome the overhead, a compact multi-context switch is developed using on a floating-gate-MOS functional pass gate which merges threshold operation and storage function on a single floating-gate MOS transistor.

14:30 7-3

### Novel-Device-Based Circuit Architecture for New-Paradigm VLSI Computation

**Takahiro Hanyu, RIEC, Tohoku University**

In order to reduce power dissipation as well as operating delay due to interconnection complexity between memory and logic modules in recent nano-scaled VLSI chip, this paper presents a new circuit technique using novel devices/materials, called nonvolatile logic. The use of logic-in-memory VLSI architecture, where storage elements are distributed over a logic-circuit plane, makes global wires reduced greatly. To implement a logic-in-memory VLSI compactly, we utilize multi-functional and nonvolatile devices such as TMR devices. Some concrete circuit techniques are demonstrated and their usefulness discussed in a specific application.

14:45 7-4

## High-Accuracy Machine Vision Technology Using Phase-Only Correlation

**Takafumi Aoki, Tohoku University**

This paper presents fundamentals and potential applications of the Phase-Only Correlation (POC) technique --- a high-accuracy image matching technique using phase information of discrete Fourier transform. Since 1990s, our research group has developed a novel technique of phase-based image matching for biometric authentication, achieving commercial application of a series of fingerprint verification systems. The same technique has also been successfully applied to high-speed image recognition systems for industrial machine vision applications. On the basis of these developments, we have recently proposed an efficient image correspondence algorithm using POC, which can find pairs of corresponding points between the given two images with sub-pixel accuracy. The proposed algorithm allows us to apply the POC technique to a wide range of computer vision applications, including smart image sensors, super-resolution video signal processing, microscope image analysis, 3D machine vision systems using stereo cameras, automotive vision systems for driver assistance, human interface for advanced home appliances and biometrics authentication techniques employing a variety of biometrics features (e.g., fingerprint, palmprint, iris, dental radiograph and 3D facial data).

15:00 7-5

## Realization of Advanced Acoustic and Multi-Modal Information Systems

**Yôiti Suzuki, RIEC, Tohoku University**

Human beings are to be regarded as extreme source and recipient of information in any communication systems. Therefore, to develop advanced acoustic communication systems, good knowledge of human auditory system as well as multi-modal perception relating to hearing is essential. Our main interest is thus a study of information processing in human auditory system. Moreover, we investigate human multi-modal information processing including hearing. At the same time, we aim at the realization of a 'comfortable' sound environment exploiting digital signal-processing techniques based on human hearing and multi-modal perceptual processing. Three-dimensional sound image control by high-definition virtual auditory displays based on simulating transfer functions of sound paths from sources to listeners' ears, and a sound field simulator based on precise sound field analysis and control are two examples. These systems are expected to provide a high-quality 3D virtual sound space, which is required to realize in multimedia communication, cyberspace systems, and super-definition audio-visual display systems. Moreover, we investigate the spatiotemporal integration process of audio-visual and audio-vestibular information. Furthermore, we developed signal- processing algorithms of digital watermarking, safer and robust VoIP communication, advanced digital hearing aids, and high-performance binaural speech enhancement system, which will contribute to more secure and stress-free universal communication systems.

15:15-15:45 Coffee Break

# Session 8 (Ball A) Tuesday, July 15th, 15:45-16:45

## Computing and Algorithm

15:45 8-1 **TyPiCal: A Type-Based Analyzer for the Pi-Calculus**

**Naoki Kobayashi, Tohoku University**

This paper introduces TyPiCal, a type-based static analysis tool for message-passing concurrent programs. It takes a pi-calculus program as an input, and analyzes various properties of the program, such as termination (the property that the program terminates for arbitrary inputs), lock-freedom (the property that certain communications will eventually succeed), and secure information flow (the property that information about confidential data is not leaked to the public). After giving an overview of the tool, we explain the underlying theory briefly.

16:00 8-2 **Consistent Digital Rays**

**Takeshi Tokuyama, Tohoku University**

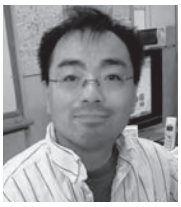
We give a novel definition of digital rays in a digital grid, which is a natural and rigorous analogue of the set of Euclidean rays emanated from the origin. A set of digital objects is called consistent digital rays (resp. segments) if it satisfies a natural analogue of Euclidean axioms for rays (resp. line segments). We give a mathematical bounds of straightness of such digital rays, and construction of the most straight consistent digital rays. The definition of consistent digital rays enables us to compute the optimal approximation of a given terrain by a mountain shape attaining the least square error. This talk is based on a paper presented in the 24th ACM Annual Symposium in Computational Geometry (June 11 2008, Washington DC).

16:15 8-3 **Optimal Realizations of State-Space Digital Filters**

**Masayuki Kawamata, Tohoku University**

This paper reviews our recent study on optimal realizations of state- space digital filters. The review consists of two parts.The first parts deals with the grammian preserving frequency transformation of state-space digital filters.This type of frequency transformation enables us to synthesize optimal realizations of state-space digital filters in the sense of minimum roundoff noise and minimum sensitivity directly from some prototype of optimal realizations.The second parts deals with synthesis of optimal realizations of 2nd order state-space digital filters in the sense of minimum $L_2$ sensitivity.

16:30 8-4 **Probabilistic Information Processing and Bayesian Networks**



**Kazuyuki Tanaka, Tohoku University**

Bayesian network is one of the methods for probabilistic inferences in artificial intelligence. Some probabilistic models for information processing are also regarded as Bayesian networks. Many researchers in computer sciences and statistics are interested in probabilistic information processing as one of the powerful methods to treat uncertainty of massive data in the real world successfully and systematically. However, many probabilistic models for information processing are massive and it is hard to calculate statistical quantities, for example, averages, variances and so on, exactly. We have to employ an approximate algorithm to calculate statistical quantities. As one of the approximate algorithms for probabilistic inferences by means of Bayesian networks, belief propagations have been investigated. Recently, belief propagations have been applied to the probabilistic information processing. In this talk, some recent theoretical developments of the Bayesian network in probabilistic information processing are reviewed. The first part is an introduction of the basic framework of Bayesian networks. The second part is a survey of belief propagation, which is one of key applications for large scale probabilistic information processing systems.

16:45-17:00 Closing Session

# Poster Session

## Monday, July 14th, 2008

## 16:45-18:00

Ball B

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|---|---|
| PO-01 | **Study on Si(111)7×7 Surface Using Non-Contact Scanning Nonlinear Dielectric Microscopy**<br>**Yasuo Cho, RIEC, Tohoku University** |
| PO-02 | **Development of a Micro-LFB Ultrasonic Device and Its Application to Elastic Inhomogeneity Evaluation of ZnO Crystal**<br>**Jun-ichi Kushibiki, Tohoku University** |
| PO-03 | **Measurement of Cross-Phase Modulation at a Single-Photon Level**<br>**Keiichi Edamatsu, RIEC, Tohoku University** |
| PO-04 | **Establishment of High Accuracy Measurement Method of LC Parameters and Surface Alignment Control for High Performance Liquid Crystal Device**<br>**Tatsuo Uchida, Tohoku Unicersity** |
| PO-05 | **Recent Activities on Ultrahigh-Speed Optical Communication**<br>**Masataka Nakazawa, RIEC, Tohoku University** |
| PO-06 | **Design of High-Performance Optical Switches**<br>**Susumu Horiguchi, Tohoku Unicersity** |
| PO-07 | **Broadband Wireless Distributed Signal Processing and Network Technology**<br>**Fumiyuki Adachi, Tohoku University** |
| PO-08 | **Performance of Modulated Scattering Array Antennas for Mobile Handsets in MIMO Transmission System**<br>**Kunio Sawaya, Tohoku University** |
| PO-09 | **A New Data Gathering Scheme Based on Set Covering Technique for Mobile Sinks in WSNs**<br>**Nei Kato, Tohoku University** |
| PO-10 | **Nanodevice-Oriented Nanoscopic Plasma Procoss Control**<br>**Rikizo Hatakeyama, Tohoku University** |
| PO-11 | **In-Situ and Real-Time TEM Observation of Electrochemical Reactions at Solid-Liquid Interfaces**<br>**Michio Niwano, RIEC, Tohoku University** |

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|---|---|
| PO-12 | **Atomically Controlled Processing for Future Si-Based Devices**<br>**Jun-ichi Murota, RIEC, Tohoku University** |
| PO-13 | **Magnetic Nano-Technologies in Recording Theories and Recording Media for High Density Perpendicular Magnetic Recording**<br>**Hiroaki Muraoka, RIEC, Tohoku University** |
| PO-14 | **Tailor-Made Nano Structured Material for Highly Qualified Spin Related Devices**<br>**Migaku Takahashi, NICHe, Tohoku University** |
| PO-15 | **Semiconductor Spintronics**<br>**Hideo Ohno, RIEC, Tohoku University** |
| PO-16 | **Fine-Grained Low-Power Reconfigurable VLSI for Real-World Applications**<br>**Michitaka Kameyama, Tohoku University** |
| PO-17 | **Novel-Device-Based Circuit Architecture for New-Paradigm VLSI Computation**<br>**Takahiro Hanyu, RIEC, Tohoku University** |
| PO-18 | **High-Accuracy Machine Vision Technology Using Phase-Only Correlation**<br>**Takafumi Aoki, Tohoku University** |
| PO-19 | **Realization of Advanced Acoustic and Multi-Modal Information Systems**<br>**Yôiti Suzuki, RIEC, Tohoku University** |
| PO-20 | **TyPiCal: A Type-Based Analyzer for the Pi-Calculus**<br>**Naoki Kobayashi, Tohoku University** |
| PO-21 | **Consistent Digital Rays**<br>**Takeshi Tokuyama, Tohoku University** |
| PO-22 | **Optimal Realizations of State-Space Digital Filters**<br>**Masayuki Kawamata, Tohoku University** |
| PO-23 | **Probabilistic Information Processing and Bayesian Networks**<br>**Kazuyuki Tanaka, Tohoku University** |

# Conference Space Layout

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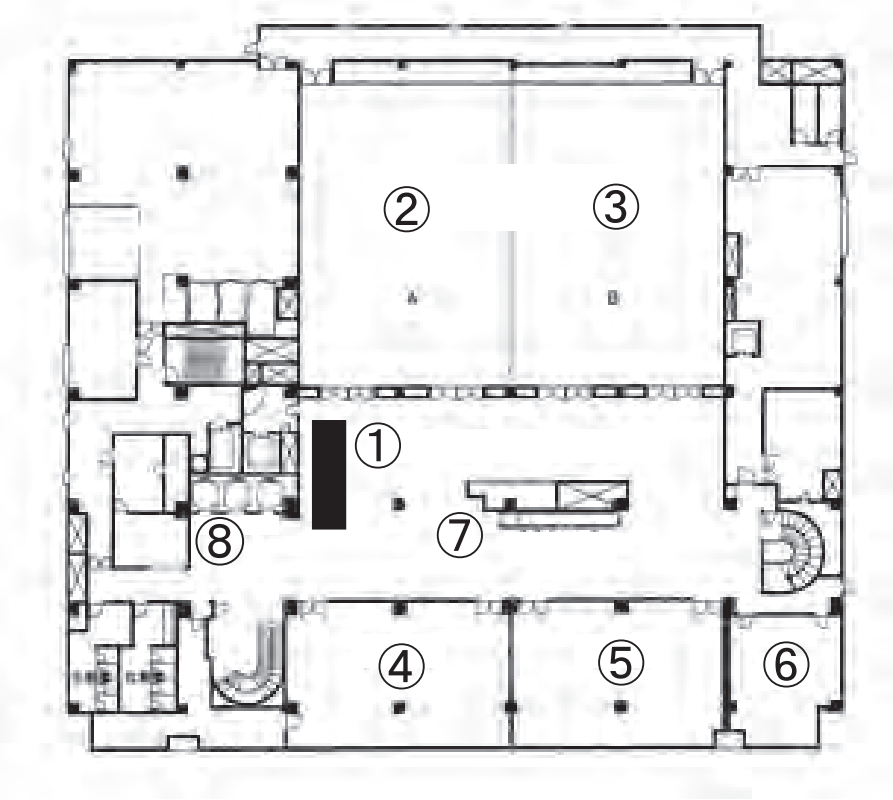


① Registration Desk
② Ball Room A
③ Ball Room B
④ Maple
⑤ Oak
⑥ Wood
⑦ Escalator
⑧ Elevator

# Transportation

**Sendai Airport**

Sendai Airport Access Line (25 minutes)

**Narita International Airport**

Railway (JR East)
Ltd. Express “Narita Express”
(60 minutes)

**Tokyo Station**

Railway (JR East)
Tohoku Shinkansen “Hayate/Komachi” or “Yamabiko”
(2.0 hours)

**Sendai Station**

**TAXI:** 5 minutes

**WALK:** 15 minutes straight down “AOBA DORI”

**BUS:** 5 minutes
Take bus marked:
(No.9 bus stop)
**715**:“宮教大" (MIYAKYODAI)
**710**"青葉台" (AOBADAI)
(No. 11 bus stop)
**700**:“緑ヶ丘三丁目” (MIDORIGAOKA)
(No. 12 bus stop)
**707**“長町南駅･長町(営)” (NAGAMACHI-MINAMI)
Get off at "晩翠草堂前" (BANSUISODO MAE). It is the second stop.

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