



World Center of Education and Research for Trans-disciplinary Flow Dynamics

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News Letter ^{Number} 03 | Post Conference Report
Special Issue



Tohoku University Global COE Program Sixth International Conference on Flow Dynamics

November 4-6, 2009

Hotel Metropolitan Sendai, Sendai, Japan





The Global Center for Flow Dynamics



Shigenao Maruyama

Distinguished Professor, Tohoku University
Program Leader of Tohoku University Global COE Program:
World Center of Education and Research for Trans-disciplinary Flow Dynamics

Tohoku Univ. has grown up to the global leading center for fluid dynamics studies through the accumulated conferences for six years supported by GCOE program.

Attendants for the Sixth International Conference on Flow Dynamics, which was chaired by Professor Jun-ichiro Mizusaki, Tohoku University, were 448 researchers and students from 17 countries, which was about 100 more than that of last year. I am very much proud of the fact that this conference is now well recognized as a world top-class academic conference in flow dynamics.

We had Japan-Korea Students' Symposium this year too. This session has a history of 10 years supported by tireless efforts by two professors, Professor Mizusaki of Tohoku University and Professor Yoo of Seoul National University, and also by the students of the organizing committee of the two universities. The

purposes of this session are to provide the students with fertile opportunities to know each other and nurture friendships, to discuss and understand in depth the research activities conducted in the two countries, and eventually, to grow-up as researchers to take world leadership in this very fundamental and crucial field of flow dynamics.

One of the new trials of this year is the Alumni Session. Main purpose of this session was to offer the alumni of Tohoku University, who once resided as professors, graduate students, post-docs and/or visiting scientists, at Tohoku University including Institute of Fluid Science, the chance to get together and exchange information by presenting and

listening to the presentations on their current works. We received 23 alumni researchers from the countries and district as Taiwan, Russia, China, India, USA and Japan. The alumni once shared and nurtured an important time, place and occasion for their carrier building-ups, at Tohoku University. I am very glad by knowing that they have enjoyed and been inspired a lot by the reunion. Future cooperation and collaboration between the alumni may also be expected. We are planning to construct a comprehensive Alumni Data Base, and through the net-works, we will communicate and distribute many important and cutting edge information in flow dynamics.

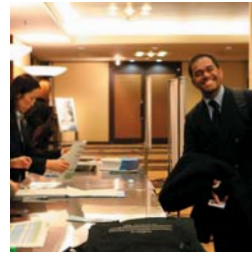
Tohoku University Global COE Program
Sixth International Conference on Flow Dynamics

November 4-6, 2009
 Hotel Metropolitan Sendai, Sendai, Japan

ICFD2009 Program

Wednesday, November 4, 2009

- Opening Address
- Plenary Lectures
- Hybrid Rocket Propulsion and Related Fluid Dynamics
- Energy and Environmental Systems over Nano/Meso/Macro Scales
- Supersonic Technology Workshop (AFI/TFI-2009)
- The Fifth International Students/Young Birds Seminar on Multi-scale Flow Dynamics
- The 10th Japan-Korea Students' Symposium -Fast Ion Transport in Solids and Through Interfaces - The Related Materials and Phenomena -
- Current Topics in Flow Dynamics
- Students /Young Birds Friendship Night



Thursday, November 5, 2009

- Functionality Design of the Contact Dynamics
- Advanced Control of Smart Fluids and Fluid Flows
- IFS Collaborative Research Forum (AFI/TFI-2009) & IFS Research Exhibition (AFI/TFI-2009)
- The Fifth International Students/Young Birds Seminar on Multi-scale Flow Dynamics
- The 10th Japan-Korea Students' Symposium -Fast Ion Transport in Solids and Through Interfaces - The Related Materials and Phenomena -
- Current Topics in Flow Dynamics
- GCOE, IFS-Tsinghua University Joint Workshop 2009
- Liaison Office Session

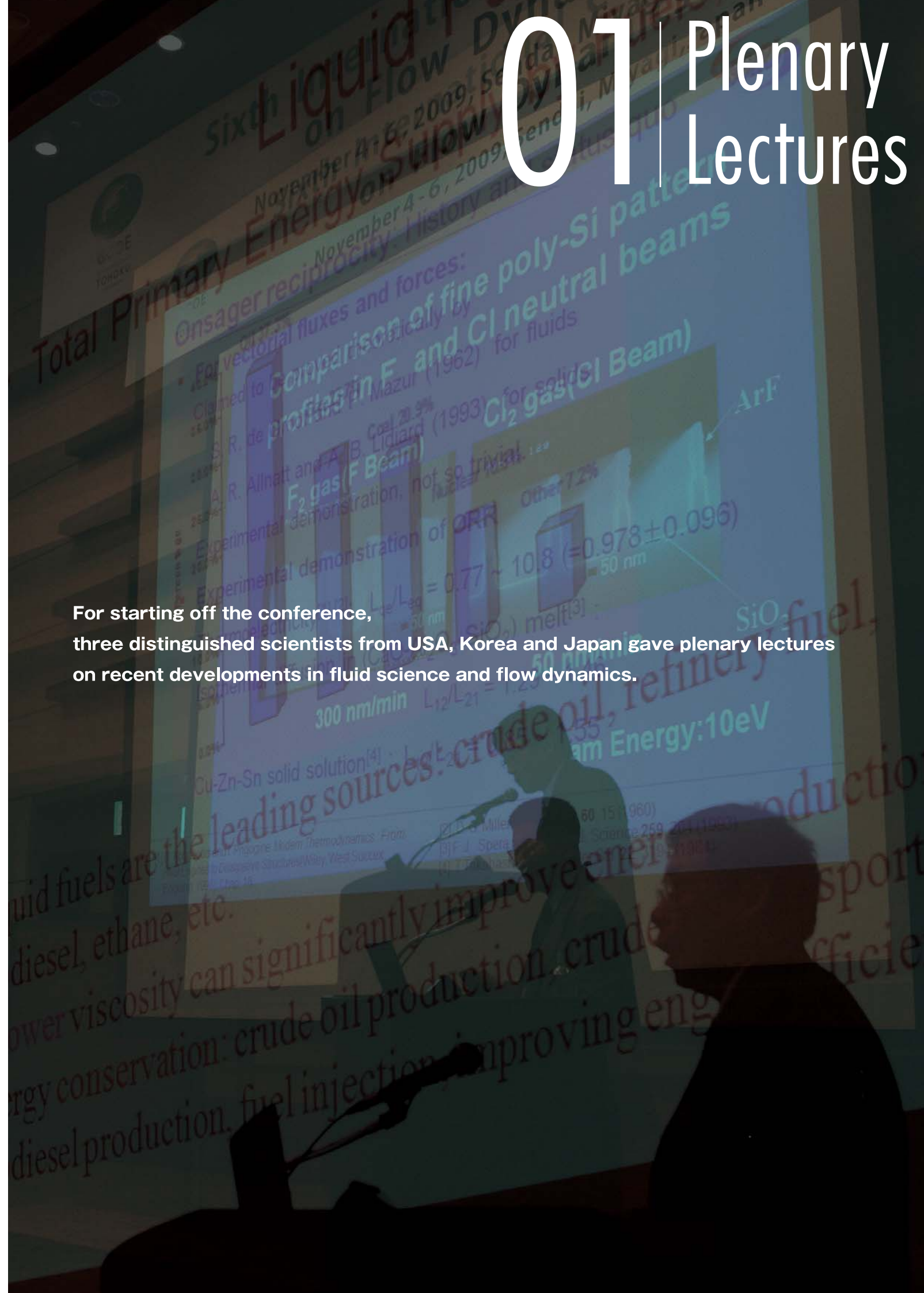
Friday, November 6, 2009

- Advanced Control of Smart Fluids and Fluid Flows
- The Fifth International Students / Young Birds Seminar on Multi-scale Flow Dynamics
- The 10th Japan-Korea Students' Symposium -Fast Ion Transport in Solids and Through Interfaces - The Related Materials and Phenomena -
- Alumni Session



01 | Plenary Lectures

For starting off the conference, three distinguished scientists from USA, Korea and Japan gave plenary lectures on recent developments in fluid science and flow dynamics.





Rongjia Tao

Professor, Temple University, USA

Rheology for Efficient Energy Production and Conservation

Presently, most of our energy comes from liquid fuels. The viscosity plays an important role in liquid fuel production, transportation, and conservation. For example, reducing viscosity of crude oil is the key to transport off-shore oil via deep water pipelines and to extract oil from oil sands. Currently, the dominant method to reduce viscosity of complex fluid is to raise its temperature. This does not only require much energy, but also raises concerns of the green house effect.

Based on the basic physics of viscosity, we recently developed a new technology to reduce the viscosity by changing the rheology of complex

fluid with electric or magnetic field. The method is energy-efficient, universal and applicable to all complex fluids with suspended particles in nanometers, sub-micrometers, or micrometers. We have applied this technology to crude oil, bio-diesel production, and refinery fuels. The results are significant. Electric or magnetic field can reduce the viscosity of asphalt-based or paraffin-based crude oil significantly. We also used electric field to reduce viscosity of diesel fuel and improved the engine efficiency. While this technology is still at early stage, it shows its tremendous merit for energy production, energy transportation, and energy conservation.



Han-Il Yoo

Professor, Seoul National University, Korea

An Odyssey to Experimental Verification of the Onsager Reciprocity in Flow of Charged Particles in Solids

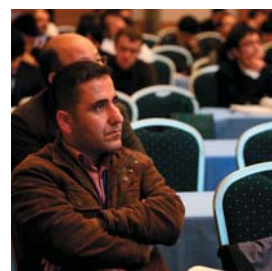
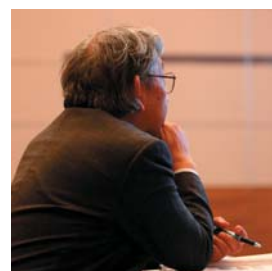
Onsager's reciprocity theorem is a key hypothesis of irreversible thermodynamics. Onsager originally derived it for the causality between flows and forces that are scalar in character. It was later claimed that the theorem is verified theoretically for those of vectorial character as well, but experimental demonstration of the reciprocity has remained by no means trivial for the vectorial processes in solid state in particular. Thus, the overall conclusion is still 'the experimental evidence is overwhelmingly in favor of the validity of the reciprocity' and 'It has not been disproved by experience'.

Through a long odyssey to experimentally verify the reciprocity, we came to measure the electron-ion cross effect to find that the effect is by no means

negligible depending on the thermodynamic state of a system, but ever failed demonstrate the reciprocity. It is only recent to be able to reach the reciprocity.

The Onsager reciprocity is firmly confirmed in the phenomenon of mixed ionic electronic conduction with a unprecedented precision or $L_{ei} / L_{ie} = 0.993 \pm 0.013$. And the cross coefficient can be even larger than the direct coefficient with many implications in treating charged particle flows in condensed systems.

Furthermore, it is noted that the cross effect is indeed by no means negligible compared to the direct effect. L_{ei} becomes even larger than L_{ii} , which will have far-reaching consequences.



Seiji Samukawa

Professor, Tohoku University, Japan

Ultimate Nanofabrication Technology by Neutral Particle Beam

Recent Ultra Large Scale Integrated Circuits (ULSI) technologies require fabrication of sub-50-nm patterns on Si-wafers. High density plasma sources, such as inductively coupled plasma (ICP) and electron cyclotron resonance plasma (ECR), are key technologies for developing precise etching processes. There are, however, potential risk factors involved in application of these sources, as charge buildup by accumulating positive ions, and defect generation by radiation of ultraviolet (UV), vacuum ultraviolet (VUV), or X-ray photons during the etching processes.

The voltages evolved by such charge buildup cause distortion of ion trajectories, breakage of thin gate dielectric films, and pattern size dependence of etching rate. Additionally, high-density crystal defects may be generated by irradiation of UV or VUV photons to the etching surface. These problems must be overcome in the fabrication of future nano-scale devices.

Our group has developed a highly efficient neutral-beam source to accomplish the ultimate top-down etching for future nano-scale devices. In the presentation today, I touch upon the issues involved in the conventional plasma etching processes and introduce an ultimate type of etching process for future devices, of from 50 to sub-10 nm, by using our new neutral-beam sources.

With this introductory part, Professor Samukawa started his lecture and introduced his new neutral-beam source for an ultimate nano-scale etching process for 20 and sub-20 nm CMOS devices, and for defect free sub-10 nm Si nano-column etching.

02 | Japan-Korea Students' Symposium

Tenth Japan-Korea Students' Symposium was held as a part of ICFD2009. This is the 10th anniversary of the Symposium, which has been held every year, in Seoul or in Sendai, alternately. Forty nine presentations by both Korean and Japanese students were made at the symposium this year.



A short discussion among the participants of the Japan-Korea Students' Symposium

Kyung-Ryul Lee

Seoul National University. D4, Korea



Jung In Yeon

Seoul National University. M2, Korea



Anna Suzuki

Tohoku University. M1, Japan



I participate consecutively in this symposium since the fifth one in Seoul in 2004. So, I know most of the students joined from Korea and Japan this year. Professor Yoo and Professor Mizusaki started this symposium 10 years ago in Seoul, with 20 students participated from the two countries. Now we have about 10 study groups and fifty students from the two countries attend the symposium this year. This is a wonderful symposium based upon wonderful ideas.

I feel there is not so big difference between Korean and Japanese students. We are in same generation and in same research area. For example, the numbers of women participants are two from Korea and two from Japan. The presence of women in academic society is still too small both in Korea and Japan. On the study side, broad studies on electronics materials are implemented in Tohoku Univ. Seoul Univ. focuses on particular electronics materials, such as electrode material. This complementary relation on research is a good basis for collaboration. Participants can learn more from other side's studies.

This is the first participation for me and the biggest problem for me was English. I decide to allocate more time to learn hearing and speaking of English because we need English to have good communication. For me it seems Korean students are more positive to discuss. This must come from the fact that they are better English speaker.



Yasuhiro Fukuda

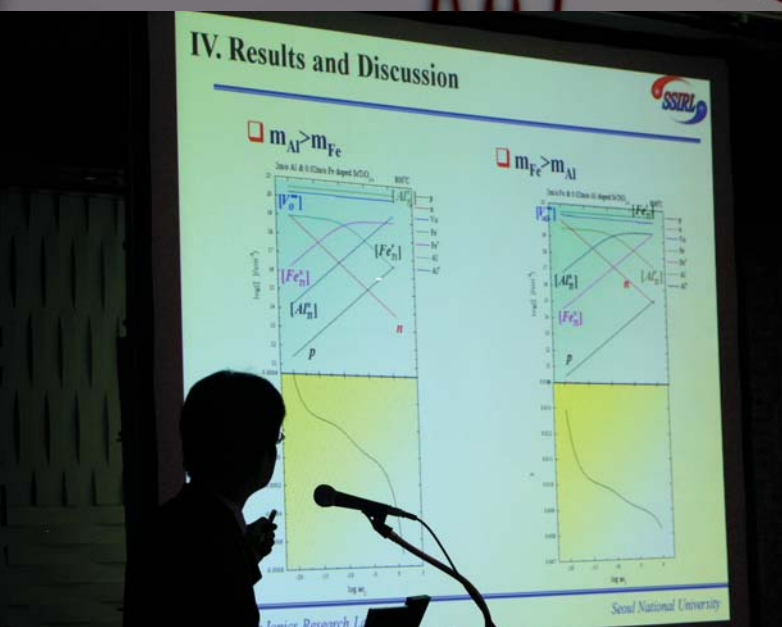
Tohoku University. M2, Japan

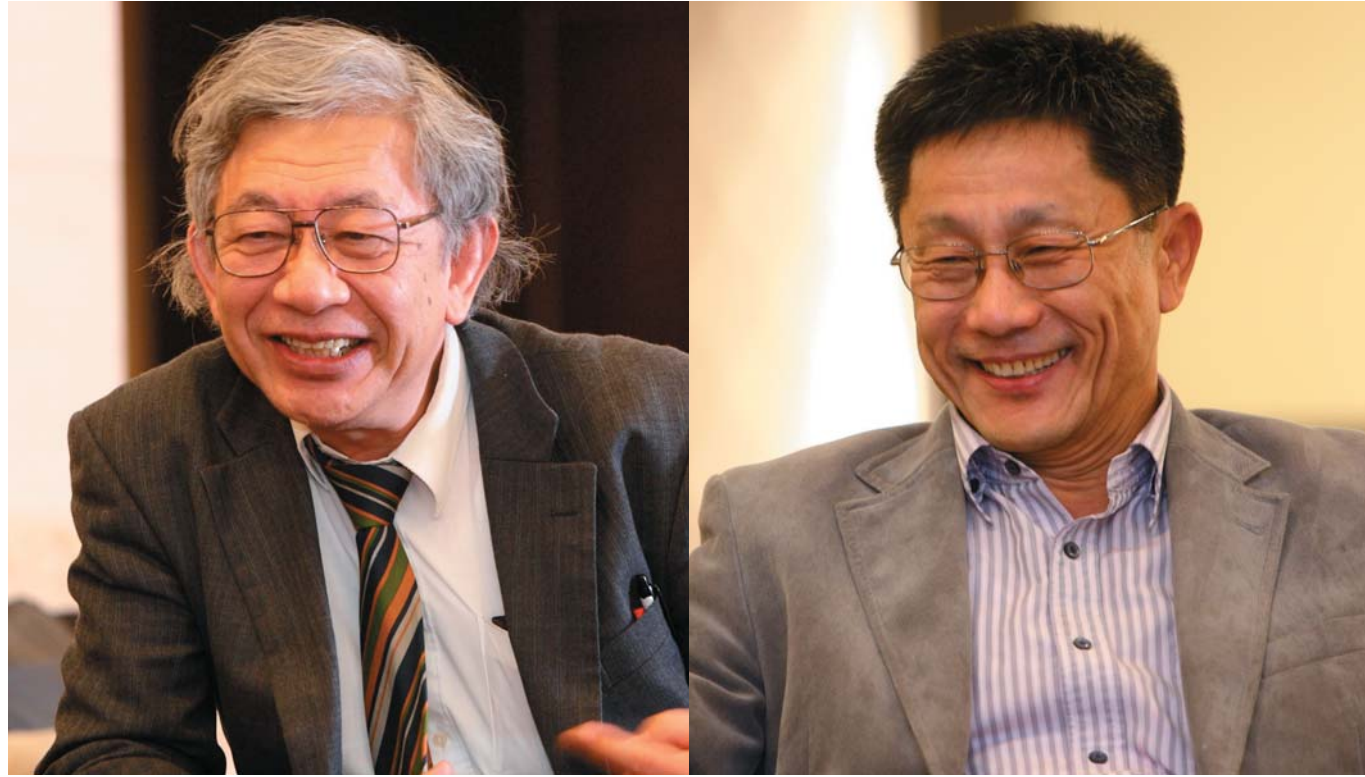


It is a good contrast to Seoul which is a dynamic and noisy city. I feel I am relaxed in Sendai. Sendai is my second home city now.

Lee gave me a smile at the end of one's sleeve to say so.

That's right. The idea of a symposium "of the student, by the students, for the students" is wonderful. This session gave me a good opportunity to get social experience and general knowledge which students in class room tend to lack. I learned about military service obligation for men in Korea first time here from a Korean student. I recognized that I was too ignorant on important facts of the world. I will learn more about realities of the world. From this symposium, I learned both academic and social matters.





Professor's talk between Junichiro Mizusaki and Han-Il Yoo

Everything started from a chat 10 years ago

Mizusaki: The idea of this Japan-Korea Students' Symposium came out at a chat between us ten years ago when Prof. Yoo stayed at Tohoku Univ. as a visiting professor. He joined the weekly seminar of my laboratory and discussed with the Japanese students on the research and investigation of my laboratory. One day after the seminar, he said to me "It will be more efficient if we can discuss together with my students." I also felt the same when I made a lecture on our recent investigations and experimental methods to Korean students as a visiting professor in Seoul in the previous year. Starting from this conversation, the basic idea for this Japan-Korea Students Symposium was made, where professors and students from both side gather at a same place and present their studies and have discussions.

Symposium of the students, by the students, for the students

Yoo: We were very fortunate because we could get financial support from Brain Korea 21 on Korean side and Center of Excellence from Japanese side. The most important thing we considered at the first time was volunteerism of the students. Organizers are selected from both sides and they themselves set up the



program for the symposium via e-mail correspondences. Then, they collect manuscripts of presentations and issue the proceedings prior to the symposium. Students do these works by themselves. The main spirit of this series of symposia is "of the students, by the students, for the students." We are very much proud of our students in that they have never failed to publish the proceedings up to this symposium. I am sure that they will keep this tradition in future.

From silence to friendly academic gala

Mizusaki: Looking back the past, silence was dominant at the first symposium. It was broken at the coffee break and lunch time at the second symposium and equal and vivid discussion emerged at around the fifth symposium, much more useful and better than the discussion in usual international academic conferences. Now, discussion is very

active not only during the sessions but also at a chat time at evening and excursion after symposium. Now we have a tradition in our laboratories in both countries in which friendship has been grown beyond the walls of national border, languages and laboratories. Newly joined students can easily and quickly get accustomed to it.

The thickness of the proceedings tells the history

Yoo: The areas these students study are solid state ionics and its applications for energy and environment in particular. The young nuclei people in this academic area from Korea and Japan are now bringing up their friendship at their twenties. The symbols of this friendship are the proceedings for ten years of this symposium. These proceedings are full of both progress of studies and development of friendship.



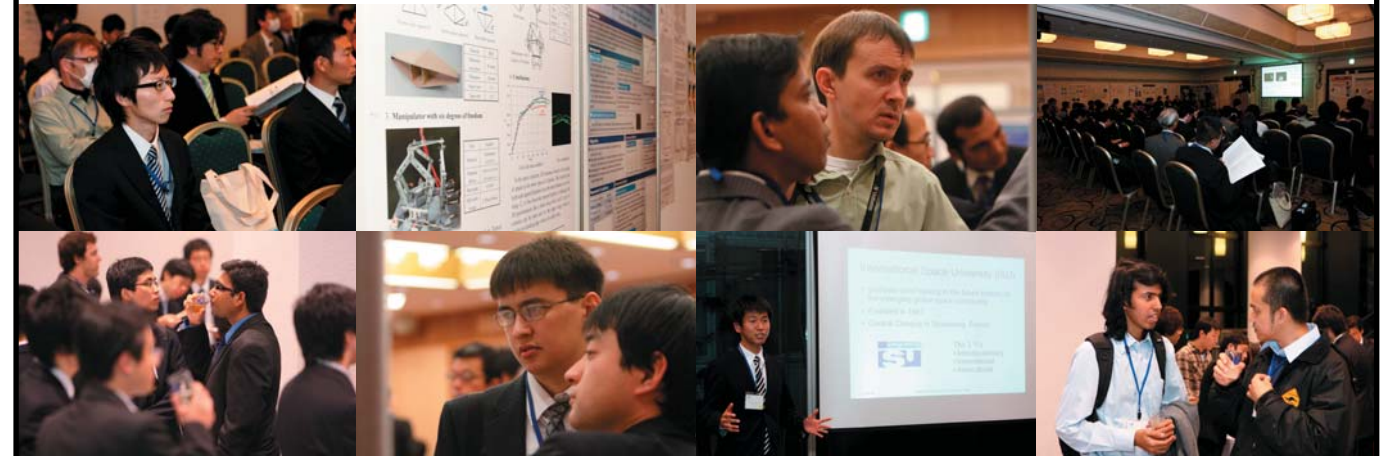
The 5th Students/Young Birds Seminar

At the Students/Young Birds Seminar,
76 students from 10 countries made presentations.
Out of them, 31 came from other countries than Japan.



Organizer
Yasuhiro Saito Tohoku University, D2, Japan

The student / young bird session is organized by students themselves. Nothing can be done unless students do. For having a small beer party at the first night of the session, we have to take the budget from the foundation, rent the party hall, prepare the food and drink, clean up the hall after party by ourselves. These were not very easy things. This year we allocated presentations randomly instead of concentrating particular area presentation to particular time. A presentation on chemical study came after a presentation on aerodynamics. We allocated presentations this way because young students have to open their eyes to many areas of science on their early stage of research. We set up voting box in the hall for presentation. Student audiences can vote for each presentation telling their estimation on the study. Best estimated presentations are awarded. Fortunately, I got an award on my study on CFD related research for chemical industry. This gave me a big confidence. I made a first presentation in English at this seminar last year and I myself became the organizer of this session. What I got through these experiences was getting guts. Speech at the presentation and writing emails to overseas students gave me a substantial progress of my English ability. I also get some administrative ability by organizing this seminar. Good trainings.



Xiaolei Wang
Tohoku University, M1, Japan

Today I presented my research "A Simulation of Fragmentation Reaction of Fucosylated Oligosaccharides by Using Quantum Chemical Molecular Dynamics (UAQCMD) Method." I used a computer to simulate where the fragmentation points are within oligosaccharides molecular. This research has been developed by Miyamoto laboratory's original program. It was challenging to apply UAQCMD method to macromolecule, however, I got good results.

I'm originally from Heilongjiang Province, China, that is colder than Sendai. I hope to come back to China, and wish to contribute to its modernization after studying hard in Japan.



Khorshed MD Alam
Tohoku University, D2, Japan

My presentation today is about "Ultra Accelerated Quantum Chemical Molecular Dynamics Study of Surface Reduction Process of CeO₂(111) and CeO₂(110) by H₂." I used UAQCMD, originally developed by Miyamoto laboratory, to find out the interactions on the ceria. Hydrogen that crash with high energy are absorbed on the ceria, which pulls up an oxygen atom from the ceria surface and results in the formation of a H₂O. CeO₂(Cerium) is a very important catalyst material used for various purposes, such as automotive exhaust catalyst, oxygen storage, the oxidation of hydrocarbons and CO, and decomposition of alcohol and aldehydes. Catalyst is widely used. Revealing the details of its reaction dynamics is very important challenge for industry and environment.

I started my study at Tohoku University two years ago after graduating from Dhaka University in Bangladesh. Now I get used to the cold, though, it surprised me so much for the first time. I haven't decided what to do after my PhD, but hope to contribute to the advancement of science by becoming an independent scientist in the future.



Farouq Ahmed
Tohoku University, D2, Japan

My presentation today is on "Influence of the Surface Hydrogen Vacancy for the Dissociative Adsorption of H₂ on Pd (111) surface."

In this study, we have demonstrated and examined successfully the individual steps of hydrogen dissociative adsorption based on theoretical studies of UAQCMD and using the H₂ and Pd (111) as a prototype model.

Our study clearly demonstrated that dissociative adsorption of H₂ requires at least three or more hydrogen vacancy on Pd (111) surface. These results agree very well with previous experimental and theoretical results.

This research is related to hydrogen storage, which plays an important role in base technology for fuel cell development. Study of both of hydrogen storage and H₂ adsorption are very important for future energy related technology, environment and industry. I am proud of my current research.



Makoto Mori
Tohoku University, M2, Japan

The presentation I made today is "Estimation of Kinetic Parameters of Polymer Pyrolysis in High-Temperature Air Combustion Combining Experiment and Numerical Analysis." Characteristics of pyrolysis and combustion of polymers in a stagnation point flow were investigated experimentally and we proposed a new method to estimate the kinetic parameters of polymer pyrolysis combining experiments and numerical analysis. The regression rates recalculated using the kinetic parameters obtained by this method were in good agreement with experimental ones, indicating the high feasibility of this method.

This study is an important basic research for the conservation of our environment because this will be applied to the pyrolysis and combustion of polyethylene and polypropylene.

03 Alumni Session

The Alumni Session was organized for the first time, in this conference. One of the main purposes of this session is to provide opportunities to Tohoku University Alumni to introduce each other of their current research and other activities at their working universities and institutions. We expect this session will enhance the activities like collaborative studies and student exchanges in future.



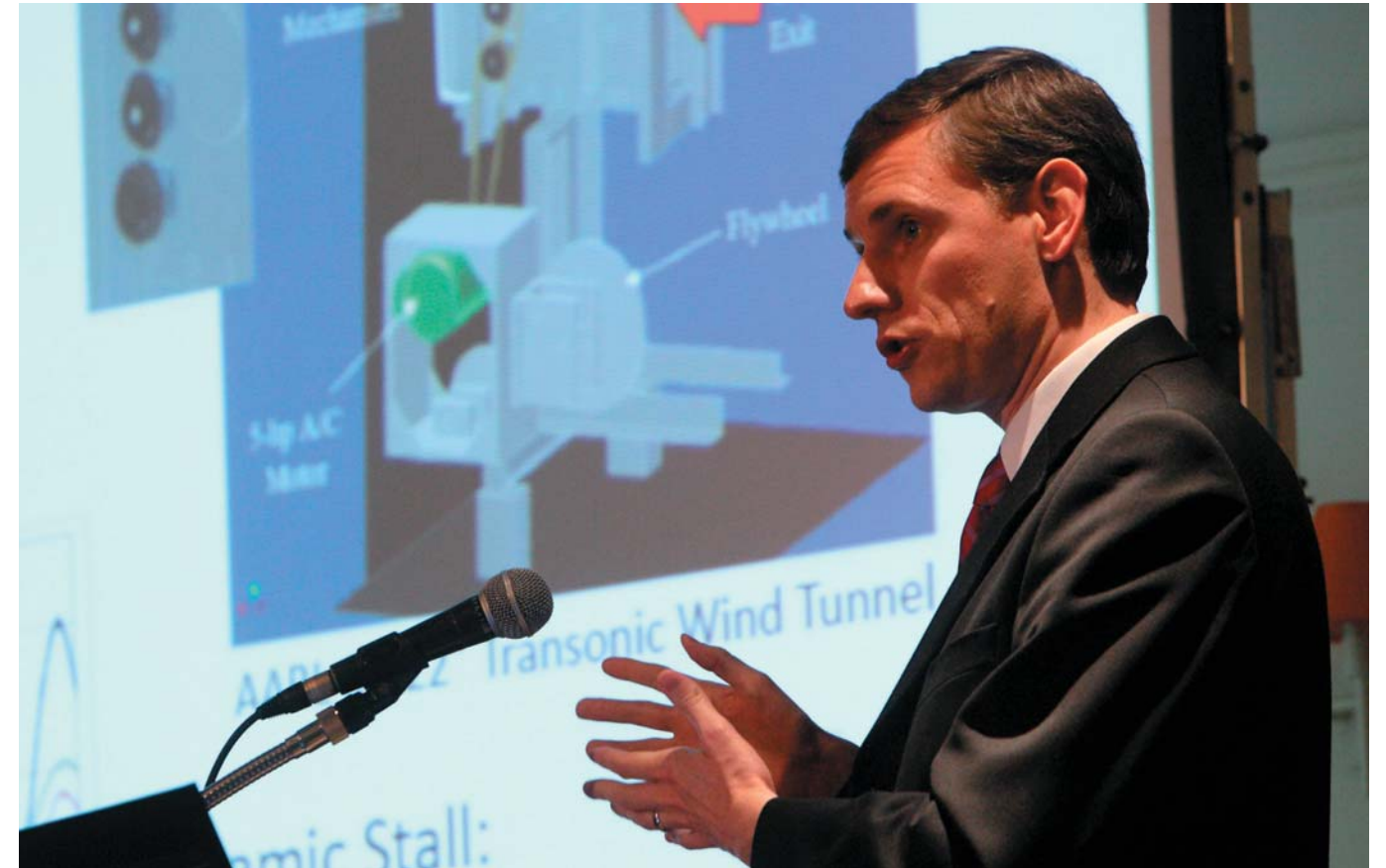
Goro Obinata Professor, Nagoya University, Japan

Based upon the studies at former Institute of High Speed Mechanics (now IFS,) I am on a leading position to develop a strong tie between industries and academy in Nagoya University

I gained my doctorate at IHSM which was called still Institute of High Speed Mechanics at that time. I went to Akita Univ. after Tohoku Univ. and now working for Ecotopia Science Institute at Nagoya University as a professor. The Ecotopia Institute is the first attached institute to nationally funded university founded after national universities became independent entities in 2004. The aims of this institute are to search for ways and measures for environmentally harmonized and sustainable society based upon advanced science and technology. The institute is really an inter-disciplinary organization and hires 25 professors who came not only from natural

science but also from social and cultural sciences. Nagoya Univ. is a Global Center of Excellence for micro-nano mechatronics area as IFS for fluid dynamics. I join the GCOE program as a research member for robotics. I am also working as an assistant to the president of the University for coordinating between industry and academy around Nagoya area. I work very hard every day for these works. In Nagoya area, there are factories of big manufacturing companies, such as Toyota and Mitsubishi Heavy Industry, and this makes Nagoya a center of automobile and aircraft industry in Japan. Having this

background, we have strongly developed research of industry academy coordination. This background makes advanced studies, such as Ecotopia and micro-nano mechatronics. Although Tohoku Univ. lacks such location merits as Nagoya Univ. has, they also implement very brisk research activities as we do in Nagoya. I really think the presence of IFS which covers many study themes beyond sections of engineering science. IFS is my home. I never forget the home town I was born as a researcher. I will make best things to support my home whose name is Institute of Fluid Science. I hope this alumni session is a good start for this kind of support.



James W. Gregory Assistant Professor, The Ohio State University, USA

Recent Development of Unsteady Pressure Sensitive Paint Technology

I stayed for several weeks in Sendai in summer of 2004 as an International Internship Student supported by the 21COE program. I studied at Professor Keisuke Asai's laboratory on porous binders used for pressure sensitive paint. A part of the results of my presentation at this conference "Recent Development in Unsteady Pressure Sensitive Paint Methods" was obtained at the time of my stay at Tohoku University. In that sense, the stay in Sendai contributes to the building-up of my professional carrier. Pressure sensitive paint (PSP) is a paint which shows the changes of brightness with the change of air pressure. Professor Asai and his laboratory people carried out an interesting experimental test to place a rugby ball coated with PSP in wind

tunnel under variable air flow. They observed and recorded the change of brightness of certain location of the surface of the ball with the change of air velocity. That is not only scientifically meaningful but a big fun to us all. This PSP technology is expected to help aircraft design engineering very much in a near future. It was an exciting experience to stay in Sendai. Before that time, Tokyo was the only city I ever visited in Japan. Once I came to Sendai, however, I was really enchanted by Sendai and Tohoku University. I was impressed particularly by the activities and accomplishments achieved at the Institute of Fluid Sciences (IFS), by the professionals who came from different fields with different capacities. IFS, by back to back

assignment as the 21COE and the GCOE program by MEXT, is further empowered to produce decent outcomes in trans-disciplinary flow dynamics. Ohio State University which I am now working for is located in Columbus, Ohio. Columbus is also a very beautiful city with Scioto River running through the city, as Hirose River runs through Sendai. The university owns an airport right next to the campus and we have several aircrafts used for research and other activities of the university. I hope I can manage some kind of collaborative studies between the two universities in future. The Alumni Session of this ICFD2009 gave really a great opportunity for me to deepen the friendship of us all, and to be inspired for new challenges in this interesting scientific field.

04 | Liaison Office Session

Participants total: 347. Participants from overseas: 108 (18 countries)

Platforms for Education and Research for Trans-disciplinary Flow Dynamics are set on global basis. Forty seven Academic Exchange Agreements with universities and research institutions of twenty countries, six Liaison Offices and International Joint Laboratories stimulated and promoted to generate many international collaborative research projects, many international conferences and symposia, intense activities as student exchanges by International Internship Program, and a strategic project as Tohoku-Lyon Summer School 2009.



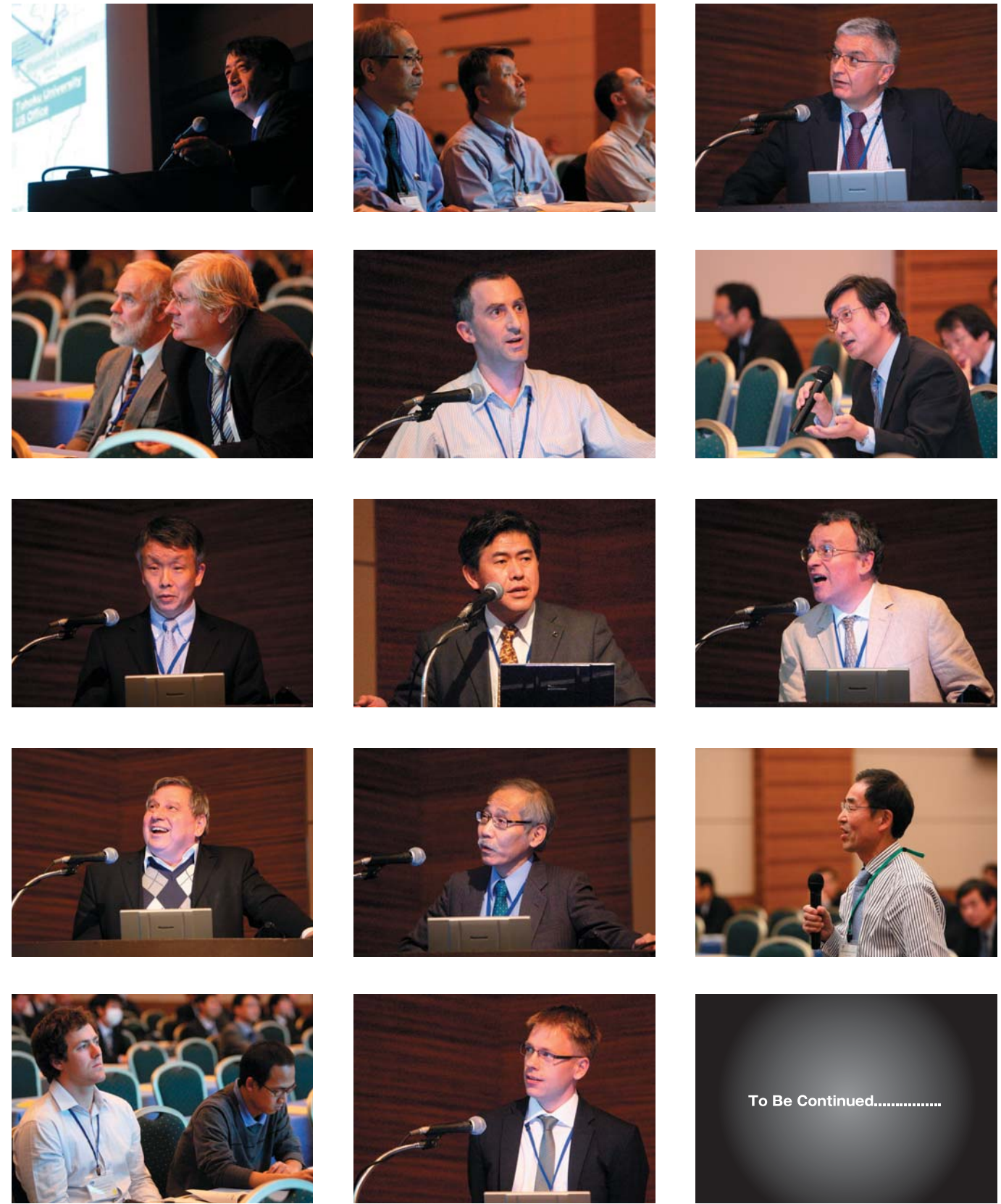
Toshiyuki Takagi Professor, Tohoku University
Program Sub-Leader, Tohoku University Global COE Program:
World Center of Education and Research for Trans-disciplinary Flow Dynamics

A meaningful international conference where world top class research outcomes are presented, substantially discussed and developed for the future

Since the beginning of the 21st Century COE program, we have established 47 academic exchange agreements with universities and research institutes in twenty countries in the world. Furthermore, we have been very positive to establish liaison offices and joint laboratories globally. These efforts resulted in the numbers of the researchers visited to this conference from overseas. The "International Conference on Flow Dynamics" has got a great result for Tohoku University to seek for being the "New International Collaborative Research Center." Our assets are affluent research exchanges with many universities and institutes. This conference is very meaningful where world top class research outcomes are presented, substantially discussed

and developed for the future. Researchers will be stimulated by other researchers' studies with new ideas and make progress in their studies. They can grow through attending this kind of top level academic conference. What is necessary is to come together and discuss. Our multistage network we brought up for a long time is the suitable asset to realize this goal. The study bears true useful outcomes upon the continued effort from past to future. The continuity is the decisive measure to get power. We believe we are the only one research institute which has a consistent research system from basic to application in the area of fluid dynamics. We are seeking to be the only one research institute of the "New International Collaborative Research Center."

We discussed about the establishment of new summer schools concept based upon multi-stage network supported by the liaison office system. We decided to keep discussion on this matter seeking for having summer schools on next year of 2010. Our eyes look futures ahead. We have got new inspirations first class presentations and discussions provided this international conference. We share the hope to have better research outcomes and discussions in the next year's conference. This hope is the resource of development of research and ultimate significance of presiding over this conference. Our mission as researchers is how far can we reach in our research and progresses can be made until next conference.



To Be Continued.....