Conference Report

Report on the Thin Film and Surface Physics Division Conference

Yasuhiko FUJITA

This report is a summary overview of recent research trends and new developments based on papers presented at the Thin Film and Surface Physics Division Conference held at Niigata University in the fall of 2002 under the sponsorship of the Japan Society of Applied Physics.

Covering a broad range of areas relating to thin films and surface physics, the conference is divided into six sub-areas of research, and a total of 474 papers were presented at this year's conference, an increase of 12% over last year. This increase was seen across the board for all areas. Some 77 of the presentations were recipients of Best Paper Awards (more than ever before) and the conference provides an ideal forum for the graduate students and young scientists who will be responsible for future advances to play an active role in delivering lively presentations and engaging in spirited question-and-answer sessions. This report will highlight a few of the papers in each research category that exemplify the current trends and unique developments in each of the areas covered by the conference.

[1] Ferroelectric Thin Film Research

Recent developments in the area of ferroelectric thin-film research were well represented at the conference. We are seeing a steady stream of new ferroelectric and dielectric materials that exhibit improved physical properties. Even regarding PZT that has been extensively investigated in the past, papers reported ferroelectricity in films thinner than 20 nm in thickness, films with robust non-fatigue properties grown at temperatures below 400°C, and a remanent polarization value exceeding 100 μC/cm^2. Remarkable progress was made in addressing some of the unsettled issues that have plagued this area over the last few years.

[2] Carbon Thin-film Research

The presentations in this area always drew overflow audiences of over a hundred people, and 24 papers were presented relating to carbon nanotubes and other new developments. The presentations ranged from nanotube fabrication using CVD and RF plasma methods to several new application developments, but especially noteworthy those were the recent work on self-organization, growth of micro-bridges, and applications such as microscope probes. Today, there is enormous interest in nanotube-related studies, and we are seeing an increasing number of papers touching on this technology in other specialized areas such as probe microscopy as well.

[3] Oxide Electronics Research

Launched as a separate session beginning with this conference, a total of 45 papers were presented over a two-day period that stirred intense debates. Here I will highlight just a few of the papers that made a strong impression. One paper that attracted a lot of interest described the first successful growth of single-crystal homologous compound $InGaO_3(ZnO)5$ films, and excellent electrical properties of FETs fabricated with their films (Materials and Structures Lab., Tokyo Institute of Technology). Low-resistance transparent conductive films have long been sought for fabricating oxide devices, and another interesting paper presented numerical calculations of dopant energy levels for several materials used as dopants in In_2O_3. Sn was singled out as being a particularly effective carrier source, and Ti and Zr were also identified as potentially useful dopant candidates (Kansai University). Finally, a technique for minimizing the resistance value of ITO deposited on plastic substrate through a laser heat treatment was described, in the belief that it is suitable for developing organic device applications (Fuji Xerox).

[4] Thin-film New Material Research

The hall with seating for 100 was filled to capacity every day to hear the 80 papers presented in this area, many of which stimulated intense, lively interest and discussion. This session was distinguished by the large number of Best Paper Award presentations (about 20 papers) by graduate students and young researchers, and by the many highly motivated papers broaching new research themes. The following research topics were especially noteworthy. Many of the presentations in this area focused on functional materials such as InN and other nitride films for application to opto-electronics, transparent conductive oxide films such as ITO or ZnO, and titanium dioxide thin films for photocatalytic applications. Recently, a whole range of functional materials have been implemented as thin films, and this has opened up many new avenues of thin-film research: incorporating additional value into functional films, investigating changes in structural phase transition of thin films using synchrotron radiation from SPring-8, exploring ways to use glass films in the fabrication of nano-structures, and probing the properties of new transparent conductors.

p.t.o. >>>

Graduate school of Tokyo Metropolitan Institute of Technology
6-6 Asahigaoka, Hino 191-0065, Japan

[5] Surface Physics and Vacuum Research

The 63 papers delivered in this area were very well attended, especially the papers relating to semiconductor surface physics on the afternoon of September 26; the room was packed with over 120 people present. Here I will mention just a few of the papers that generated the most widespread interest.

One paper deserves special mention for settling a recent controversy by finding that long-studied Si(001) clean surface shows the phase transition from c(4×2) structure to p(2×2) structure when it was cooled below 10 K, and by examining this phenomenon through super-low-temperature LEED analysis for the corresponding structure at a true ground state (University of Tsukuba Group, et al.). The Best Interpretive Paper was delivered by Dr. Shozo Kohno (Tohoku University), who gave a comprehensive and systematic overview of surface structural analysis by photoelectron diffraction. Including some of the history and highlights of the method, Dr. Kohno's presentation conveyed a clear and lasting appreciation of the depth of this methodology. Dr. Kohno gave examples where the method is effective in clarifying surface structure and other examples where it is not, and then identified the surface attributes that are suitable for this kind of analysis. Turning to research trends relating to silicon surfaces, there were quite a few papers dealing with the ago-old issues of improving quality and expanding quantity. Papers were also presented on the growth of insulating layers and magnetic metallic layers, on photoelectronic holography indicating steady progress and growth of these areas. Yet, from the standpoint of basic research on surface structural analysis, the presentations were largely restricted to new methods such as photoelectronic holography; we are seeing an increasing number of papers that focus rather narrowly on (1) the dynamics of surface structure changes, and on (2) artificial nanostructure surface phenomena showing a mastery of nanotechnology micro processing methods. We are also beginning to see an increase in research seeking to incorporate greater functionality into surfaces and ultra thin films, an approach that has excellent potential in the future.

[6] Probe Microscopy Research

Some 64 papers were presented in this area, including one presentation that received the JJAP Award for the Best Original Paper. Recent research trends in this area were represented by many papers dealing with the development of carbon nanotube-based techniques and various other high-performance probe technologies, novel measurement and analysis methods, and combination of probe microscopy with other analytical techniques. It is apparent that including peripheral technologies the probe microscopy is making steady progress as a method of surface analysis. Other exceptional papers presented measurement data for vibration excitation and absorption states under limiting conditions (low temperature, single molecule), and advanced nano-processing technologies using SPM that is particularly well adapted to this kind of application. A number of developments are now starting to come together in this area—most notably, surface observations at the atomic level using non-contact atomic force microscopy, and feedback from experimental data is augmenting theoretical analysis to enhance the accuracy of hard-to-interpret images—and this should open the way to further development in this area.

Finally, let me express my thanks and appreciation to all of those who had a hand in drafting this report including Dr. Takeshi Kijima (Tokyo Institute of Technology), Dr. Hiroshi Funakubo (Tokyo Institute of Technology), Dr. Atsuhito Sawabe (Department of Physics, Aoyama Gakuin University), Dr. Fumio Kokai (National Institute of Advanced Industrial Science and Technology), Dr. Akiharu Morimoto (University of Kanazawa), Dr. Mamoru Yoshimoto (Tokyo Institute of Technology), Dr. Shuji Hasegawa (Faculty of Science, University of Tokyo), Dr. Kohji Katayama (Osaka Institute of Technology), Dr. Hidemi Shigekawa (Tsukuba University), and Dr. Masamitsu Yoshimura (Toyota Technological Institute).

JSAP INTERNATIONAL