

# The 40<sup>th</sup> Annual NANO Testing Symposium



KFC Hall  
Kokusai Fashion Center  
Sumida-ku, Tokyo, Japan  
16-18 November 2020  
<http://www-NANOTS.ist.osaka-u.ac.jp/>  
NANOTS@ist.osaka-u.ac.jp

**Sponsored by** The Institute of NANO Testing  
**In cooperation with**

- The Institute of Electronics, Information and Communication Engineers
- The Japan Society of Applied Physics
- Reliability Engineering Association of Japan
- Union of Japanese Scientists and Engineers

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We will implement the emergency measures for preventing COVID-19 infections. Please check the following URL for the response. Thank you for your cooperation.  
<https://bit.ly/32CTKWr>

## 1 Location

### Technical Sessions:

KFC Hall, Kokusai Fashion Center 1-6-1,  
Yokoami, Sumida-Ku, Tokyo, 130-0015 Japan  
Phone: +81-3-5610-5801

### Exhibition:

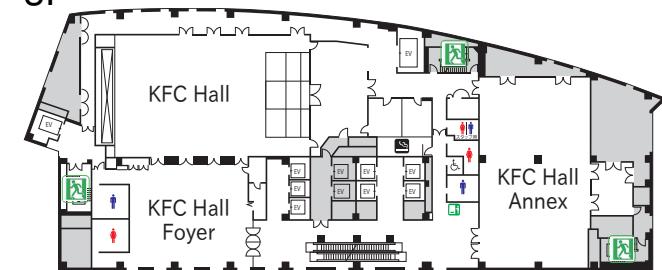
KFC Hall Annex, Kokusai Fashion Center

### Evening Session:

KFC Hall, Kokusai Fashion Center

## 2 Floor Map

3F



## 3 Special Invited Talk

The following special invited talk will be given.

16:50–17:50, Tuesday, 17 November:

“Testing of Automotive-grade Silicon Carbide Power MOSFETs for normal and abnormal operations”  
by Prof. Dr. Francesco Iannuzz, *Faculty of Engineering and Science, Aalborg University, Denmark*

## 4 Invited Talk

The following invited talks will be given.

14:20–14:50, Monday, 16 November:

“Characterization of semiconductor crystals based on omnidirectional photoluminescence (ODPL) spectroscopy”  
by Asso. Prof. Kazunobu KOJIMA, *Institute of Multidisciplinary Research for Advanced Materials, Tohoku University*

19:00–20:00, Tuesday, 17 November:  
“Possibility of diamond quantum sensor”  
by Prof. Mutsuko HATANO, *School of Engineering, Tokyo Institute of Technology*

## 5 Tutorial Session

The following tutorial sessions will be given.

9:30–10:30, Monday, 16 November:  
“Future prospects for semiconductor material and device evaluation by SNDM”  
by Prof. Yasuo CHO, *Tohoku University*

13:10–14:10, Tuesday, 17 November:  
“Procedure of Semiconductor Failure Analysis”  
by Dr. Akira SHIMASE, *Hamamatsu Photonics K.K.*

9:30–10:30, Wednesday, 18 November:  
“Application developments of machine learning and deep learning in metrology”  
by Assist. Prof. Yoshihiro MIDOH, *Osaka University*

## 6 Panel Discussion

A panel discussion on “Profile measurements of high aspect ratio patterns in memory devices” will be held on Wednesday, 18 November 15:40–16:40 in the conference hall (KFC Hall on 3F).

## 7 Authors Corner

Authors corner, a place for audience to meet with and discuss with authors, will be given just after the sessions (except for commercial sessions) in KFC Hall or KFC Hall Annex.

## 8 Evening Session

**Evening session I:**  
for discussing on research trend around the world and the future perspective.

**Evening session II:**  
Invited Talk by Prof. Hatano.

The session will be held on the Tuesday, 17 November 18:05–20:00 in KFC Hall.

## 9 Exhibition and Commercial Session

The Symposium will feature the latest in service providers, equipment manufacturers and suppliers. A large exhibit floor will give the opportunity to key-vendors to represent the core business area in these fields. Furthermore, a commercial session will give the opportunity to introduce new products with short presentation.

## 10 Official Languages

The official languages of the symposium are Japanese and English. Papers included in the proceeding will be written in Japanese or English. Papers in Japanese will have an abstract written in English. We will have no interpreter.

## 11 Registration Fee

Course	Fee	Including
Non-student	JPY 13000	All sessions, exhibition, and proceeding (download only)
Student	JPY 5000	

Please pay the fee by 6 November 2020 in one of the following ways.

**Wire Transfer:** Please send Japanese YEN (JPY) to the following account by wire transfer:

Bank Name: Resona Bank, Ltd.

SWIFT (BIC) Code: DIWAJPJT

Branch Name: Senri-Kita Branch

Branch Code: 222

Address: 4-2-D2-201, Furuedai, Suita, Osaka, 565-0874, Japan

Phone: +81-6-6872-0651

Account Number: 6843152

Account Name: The Institute of NANO Testing Nakamae Koji

**Note:** All bank charges JPY 5,000 (= the sending bank charge + the receiving bank charge) must be paid by the participant.

Credit card: Please click “Pay Now” button after you finish on-line registration.

## 12 Symposium Registration

Please register online by using our website: <http://www-NANOTS.ist.osaka-u.ac.jp/> by 6 November 2020 (punctuality).

**For preventing COVID-19 infections, this symposium is for pre-registration only, and we will not accept participation on the day. Thank you for your understanding.**

## 13 Cancellation Policy

Cancellations must be submitted in an e-mail. Cancellations received by 17:00, 6 November 2020 (in Japan Standard Time) are entitled to a refund minus an administrative fee (all bank charges plus a 10 % processing fee). No refunds will be given to registrants who cancel after 6 November 2020 or who fail to attend the event.

## 14 Accommodation Information

There is The Dai-ichi Hotel Ryogoku in the same building as the symposium venue. Please visit the following hotel's web site and book a room.

<http://www.dh-ryogoku.com/english/>

## 15 Proceedings

Technical papers will be provided on electronic media (download). Download information will be announced on November 12, 2020. The conference program will be provided on print media.

## 16 Latest Information

You can find latest information on all aspects of NANOTS at <http://www-NANOTS.ist.osaka-u.ac.jp/>.

## 17 Steering & Program Committee

### Chairman:

Koji NAKAMAE (Osaka University)

### Member:

Yasuo CHO (Tohoku University)

Yasunori GOTO (MIRISE Technologies)

Yasuhide HIGUCHI (Hitachi, Ltd.)

Toru KOYAMA (Fuji Electric Co., Ltd.)

Suigen KYOH (Kioxia Corp.)

Hitoshi MAEDA (Renesas Semiconductor Manufacturing Co., Ltd.)

Kiyoshi NIKAWA (Device Evaluation Technology Lab.)

Yoichi OSE (Hitachi High-Tech Corp.)

Hirotoshi TERADA (Hamamatsu Photonics)

Yuichiro YAMAZAKI (TASMIT Inc.)

## 18 Secretariat

Yoshihiro MIDOH and Koji NAKAMAE

Secretariat of the Institute of NANO Testing

Nakamae Lab., Dept. Information Systems Engineering,

Grad. Sch. Information Science and Technology

Osaka University

1-5, Yamada-Oka, Suita, Osaka, 565-0871 JAPAN

Phone/Fax: +81-6-6879-7813 / +81-6-6879-7812

E-mail: NANOTS@ist.osaka-u.ac.jp

Web: <http://www-NANOTS.ist.osaka-u.ac.jp/>

## 19 Technical Program

Monday, Nov. 16, a.m. / KFC Hall

### Tutorial I

a.m., Mon 16

Chairman Yasunori Goto

(T1) Future prospects for semiconductor material and device evaluation by SNDM

9:30 Y. Cho / Research Institute of Electrical Communication, Tohoku Univ.

..... 10:30~10:45 Authors corner & break .....

### Physical Analysis I

a.m., Mon 16

Chairman Toru Koyama

(1) 10:45 Carrier measurement methodology for 3D flash memory cell using scanning nonlinear dielectric microscopy

J. Hirota<sup>(a)</sup>, K. Yamasue<sup>(b)</sup>, K. Hoshino<sup>(a)</sup>, and Y. Cho<sup>(b)</sup> /

<sup>(a)</sup>Institute of Memory Technology Research &

Development, KIOXIA Corp., <sup>(b)</sup>Research Institute of

Electrical Communication, Tohoku Univ.

(2) 11:10 Investigation of contrast change in SNDM images for carrier distribution on semiconductors from the aspect of surface potential analysis using KFM

Y. Miyato, H. Nozaki, and Y. Terui / Evaluation and Analysis Technology Center, Toshiba Nanoanalysis Corp.

..... 11:35~12:05 Authors corner & break .....

..... 12:05~13:00 Lunch Break .....

Monday, Nov. 16, p.m. / KFC Hall

### Physical Analysis II

p.m., Mon 16

Chairman Yasuo Cho

(3) 13:00 STEM-EDS effective sensitivity improvement by combination of principal component analysis method and energy-corrected peak fitting

A. Sugiyama, Y. Shimada, T. Ide, and Y. Kunimune / Analysis and Evaluation Technology Dept., Device Technology Div., Production and Technology Unit, Renesas Electronics

(4) 13:25 Quantitative evaluation of N concentration of WN films using atom probe tomography

A. Sakamoto, A. Kuramoto, and T. Kinno / Institute of Memory Technology Research & Development, Kioxia Corp.

..... 13:50~14:20 Authors corner & break .....

### Invited Talk I

p.m., Mon 16

Chairman Yasunori Gto

(I1) 14:20 Characterization of semiconductor crystals based on omnidirectional photoluminescence (ODPL) spectroscopy

K. Kojima and S. Chichibu / Institute of Multidisciplinary Research for Advanced Materials, Tohoku Univ.

..... 14:50~15:05 Authors corner & break .....

### Power Device Analysis

p.m., Mon 16

Chairman Yasuhisa Higuchi

(5) 15:05 High-speed high-voltage lock-in thermography observation method using high-order harmonic analysis

K. Koshikawa<sup>(a)</sup>, K. Endo<sup>(b)</sup>, N. Chinone<sup>(a)</sup>, T. Kaneoka<sup>(a)</sup>, and T. Matsumoto<sup>(a)</sup> / Systems Div., Hamamatsu Photonics K. K., <sup>(b)</sup>Discrete Semiconductor Quality & Reliability Engineering Dept., Toshiba Electronic Devices & Storage Corp.

..... 15:30~15:45 Authors corner & break .....

### Commercial Session

p.m., Mon 16

Chairman Yasuhisa Higuchi

(C1) 15:45 New concept of nano-probing system

Y. Nakashima<sup>(a)</sup>, J. Sukegawa<sup>(a)</sup>, Y. Shibata<sup>(b)</sup>, and C. Rob<sup>(c)</sup> / Sales I Div., TOKI COMMERCIAL Co., LTD, <sup>(b)</sup>Engineering Dept., TNS Systems LLC, <sup>(c)</sup>Sales Div., Imina Technologies SA

(C2) 15:53 Complementary analysis for dislocations of GaN compound semiconductors using STEM and APT

N. Mayama<sup>(a)</sup>, K. Watanabe<sup>(a)</sup>, J. Koyama<sup>(a)</sup>, S. Ishimura<sup>(a)</sup>, M. Suganuma<sup>(a)</sup>, and M. Sugiyama<sup>(b)</sup> / <sup>(a)</sup>Physical Analysis Technology Center, Toshiba Nanoanalysis, <sup>(b)</sup>Research Center for Advanced Science and Technology, Univ. Tokyo

(C3) 16:01 Introduction of FIB circuit edit service for 16nm generation

K. Inomata, H. Kawahara, and H. Tsukui / Evaluation Analysis Dept., Renesas Engineering Services Co., Ltd.

(C4) Failure analysis for avoiding repeated product accidents?failure analysis based on nondestructive analysis?  
16:09 K. Takamori, K. Takamori, Y. Sakaki, and K. Hyoudou / Oki Engineering Co., Ltd.

(C5) High-performance FIB-SEM ethos NX5000 series - introduction of ethos NX5100/ethos NX5200 -  
16:17 M. Suzuki<sup>(a)</sup>, Y. Yamamoto<sup>(a)</sup>, N. Hirose<sup>(a)</sup>, M. Kiayohara<sup>(a)</sup>, H. Suzuki<sup>(a)</sup>, Y. Sugiyama<sup>(a)</sup>, T. Asahata<sup>(a)</sup>, and C. Kamiya<sup>(b) / (a)</sup> Beam Technology Systems Design Dept., Hitachi High-Tech Science Corp.,  
<sup>b)</sup> Electron Microscope Systems Design Dept., Hitachi High-Tech Corp.

(C6) Carrier distribution analysis in semiconductor by sMIM (scanning microwave impedance microscope)  
16:25 K. Takagi, M. Gotoh, Y. Nishioka, Y. Maegawa, and K. Atarashi / Quality Engineering Dept., ITES Co., Ltd.

(C7) Applications of laser-raman spectroscopy for semiconductors  
16:33 K. Isoo / Chemical Analysis Center, TAKASAGO Lab., Analysis, Testing & Research Business, Technology Unit, Kobelco Research Institute, Inc.

(C8) Submicron 3D X-ray microscope "PrismaXRM" with talbot-lau interferometer  
16:41 T. Ogaki / Measurement and analysis instruments Div., Sales Group2, Industrial Equipment Headquarters, Canon Marketing Japan Inc.

## Tuesday, Nov. 17, a.m. / KFC Hall

### Electron Optics & Application I a.m., Tue 17

Chairman Hitoshi Maeda

(6) Irradiation performance of pulsed electron gun using negative electron affinity (NEA) photocathode  
9:30 H. Morishita<sup>(a)</sup>, T. Ohshima<sup>(a)</sup>, K. Otsuga<sup>(a)</sup>, M. Kuwahara<sup>(b)</sup>, T. Agemura<sup>(c)</sup>, and Y. Ose<sup>(c)</sup> /  
<sup>a)</sup>Research and Development Group, Hitachi, Ltd.,  
<sup>b)</sup>Institute of Materials and Systems for Sustainability, Nagoya Univ., <sup>c)</sup>Hitachi High-Tech Corp.

(7) Improvement of phase accuracy in electron holography by noise suppression in the Fourier domain  
9:55 T. Okada, Y. Midoh, K. Nakamae, and N. Miura / Grad. Sch. Information Science and Technology, Osaka Univ.  
..... 10:20~10:50 Authors corner & break .....

### Electron Optics & Application II a.m., Tue 17

Chairman Yoichi Ose

(8) Studies of automating FIB-SEM processes  
10:50 Y. Aizawa<sup>(a)</sup>, T. Sato<sup>(a)</sup>, A. Morikawa<sup>(a)</sup>, M. Suzuki<sup>(b)</sup>, and S. Tomimatsu<sup>(b) / (a)</sup> Electron Microscope Solution Group, Hitachi High-Tech Corp., <sup>b)</sup> Beam Technology System Design Group 1, Hitachi High-Tech Science Corp.  
(9) Sample preparation for TEM analysis by FIB processing under peltier  
11:15 S. Torikawa, T. Iwahori, and T. Asahata / Beam Technology Design Dept., Hitachi High-Tech Science Corp.  
..... 11:40~12:10 Authors corner & break .....

..... 12:10~13:10 Lunch Break .....

## Tuesday, Nov. 17, p.m. / KFC Hall

### Tutorial II p.m., Tue 17

Chairman Hirotoshi Terada

(T2) Procedure of failure analysis on semiconductor devices  
13:10 A. Shimase / Semiconductor Inspection Systems Dept., Hamamatsu Photonics K. K.  
..... 14:10~14:25 Authors corner & break .....

### Fault Localization I p.m., Tue 17

Chairman Kiyoshi Nikawa

(10) A technique of IDDQ based cell-internal fault diagnosis  
14:25 S. Nomura, N. Matsui, T. Ohkubo, Y. Hanazaki, S. Wada, and H. Tsukui / Evaluation Analysis Dept., Renesas Engineering Services Co., Ltd.

(11) Effectiveness studies of EOFM (electro optical frequency mapping) for short circuit defects  
14:50 M. Saeki, Y. Matsumoto, and H. Tsukui / Evaluation Analysis Dept., Renesas Engineering Services Co., Ltd.  
..... 15:15~15:30 Authors corner & break .....

### Fault Localization II p.m., Tue 17

Chairman Hitoshi Maeda

(12) SEM based electrical probing solutions and applications for micro and nanoscale device characterization  
15:30 R. Claassen and G. Boetsch / Sales Div., Imina Technologies SA  
(13) Analytical method for the CMOS image sensor by the voltage applied EBAC  
15:55 Y. Katakurra, M. Tsujita, N. Yamauchi, and T. Kawamura / Device Engineering Div. Device Analysis Engineering Dept., Sony Semiconductor Manufacturing Corp.  
..... 16:20~16:50 Authors corner & break .....

### Special Invited Talk p.m., Tue 17

Chairman Hirotoshi Terada

(S1) Testing of automotive-grade silicon carbide power MOSFETs for normal and abnormal operations  
16:50 F. Iannuzzo / Faculty of Engineering and Science, Aalborg Univ.  
..... 17:50~18:05 Authors corner & break .....

### Evening Session I p.m., Tue 17

18:05 Evening session of NANOTS is a special session for discussing on research trend around the world and the future perspective.  
19:00

## Evening Session II Invited Talk II

p.m., Tue 17

Chairman Koji Nakamae

- (I2) 19:00 The potential of diamond solid-state quantum sensors

M. Hatano / School of Engineering, Tokyo Institute of Technology

..... 20:00 Close .....

## Wednesday, Nov. 18, a.m. / KFC Hall

### Tutorial III

a.m., Wed 18

Chairman Koji Nakamae

- (T3) 9:30 Application developments of machine learning and deep learning in metrology

Y. Midoh / Grad. Sch. Information Science and Technology, Osaka Univ.

..... 10:30~10:45 break .....

## Machine Learning for Process Control I

a.m., Wed 18

Chairman Suigen Kyoh

- (14) 10:45 AI-FDC: A modern approach to process control

R. Burch<sup>(a)</sup>, K. Kunitoshi<sup>(b)</sup>, and M. Keleher<sup>(b) / (a)</sup> AI Solutions, PDF Solutions, Inc., <sup>(b)</sup>Japan Apps and Data Integration, PDF Solutions, Inc., <sup>(c)</sup>Japan Account Management, PDF Solutions, Inc.

- (15) 11:10 Study on explainability of experimental data using a neural network with physical models

T. Takemoto, Y. Midoh, K. Nakamae, and N. Miura / Grad. Sch. Information Science and Technology, Osaka Univ.

..... 11:35~12:05 Authors corner & break .....

..... 12:05~13:00 Lunch Break .....

Wednesday, Nov. 18, p.m. / KFC Hall

## Machine Learning for Process Control II

p.m., Wed 18

Chairman Yoichi Ose

- (16) 13:00 Change-point prediction in time-series using dimension reduction and deep learning

K. Otsuka, Y. Midoh, K. Nakamae, and N. Miura / Grad. Sch. Information Science and Technology, Osaka Univ.

- (17) 13:25 Deep reinforcement learning in continuous state and action spaces under partial observation

T. Nishimura, Y. Midoh, K. Nakamae, and N. Miura / Grad. Sch. Information Science and Technology, Osaka Univ.

..... 13:50~14:20 Authors corner & break .....

## Metrology and Inspection

p.m., Wed 18

Chairman Yuichiro Yamazaki

- (18) 14:20 SEM image generator with charging effect by monte carlo simulation and deep learning

K. Iwamoto, Y. Midoh, K. Nakamae, and N. Miura / Grad. Sch. Information Science and Technology, Osaka Univ.

- (19) 14:45 Cross-sectional profile measurement of deep holes in three-dimensional devices by small angle x-ray scattering

Y. Ito, T. Goto, and K. Omote / X-ray Research Lab., Rigaku Corp.

..... 15:10~15:40 Authors corner & break .....

## Panel Discussion

p.m., Wed 18

- 15:40 Theme: Profile measurements of high aspect ratio patterns in memory devices

16:40 Moderator: Suigen Kyoh / Kioxia Corp.

Panelists:

M. Asano / Tokyo Electron Ltd.

S. Wei / Hitachi Ltd.

Y. Ito / Rigaku Corp.

N. Nakanishi / Thermo Fisher Scientific

H. Tanizaki / Kioxia Corp.

- (P1) Requirement for metrology of HAR pattern from the view point of tool vendor  
M. Asano / Tokyo Electron Ltd.

- (P2) High-voltage CD-SEM-based application to monitor 3D profile of high-aspect-ratio features  
S. Wei / Hitachi Ltd.

- (P3) Cross-sectional profile measurement of deep holes in three-dimensional devices by small angle X-ray scattering  
Y. Ito / X-ray Research Lab., Rigaku Corp.

- (P4) Metrology of high aspect ratio devices using FIB and S/TEM  
N. Nakanishi / Materials & Structural Analysis, Thermo Fisher Scientific Inc.

- (P5) Metrology requirements for 3D flash-memory  
H. Tanizaki / Institute of Memory Technology Research & Development, KIOXIA Corp.

..... 16:40~17:00 Networking with panelists .....

## 20 Author Index

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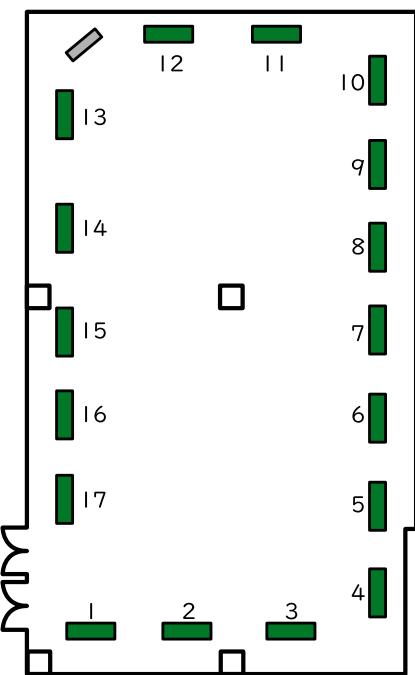
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## 21 Exhibition

### Date & time:

Monday, 16 November 2020, 13:00–17:00  
 Tuesday, 17 November 2020, 9:30–17:00  
 Wednesday, 18 November 2020, 9:30–16:00

Venue: KFC Hall Annex on 3rd floor



(The exhibition floorplan is subject to change without notice.)

1. Canon Marketing Japan Inc.: (C8)  
Submicron 3D X-ray Microscope PrismaXRM
2. Nippon Scientific Co., Ltd:  
New Laser Decapsulation system PL201D and others
3. ITES Co., Ltd.: (C6)  
Introduction of power semiconductor evaluation and analysis
4. Atomic scale elecmagnetic field analysis platform:  
Introduction of application experiments
5. HiSOL, Inc.:  
New Analysis Devices
6. Nippon barnes company, LTD.:  
Very high spatial resolution (down to 0.2 ?m) the T ° Imager

### 7. Aamilia Japan G.K.:

Optical microscopy with computational super resolution, artificial intelligence (AI) and robotics "nSpec®"

### 8. AD Science Inc.:

Sputter Coaters and Carbon Coaters, Micro Manipulators, Nano Prober, In-situ Downstream Asher

### 9. Toshiba Nanoanalysis Corporation: (C2)

Semiconductor Analysis Services (Scanning Probe Microscopy, Magnetic Microscopy, 3D Atom Probe)

### 10. TOYO Corporation:

TESCAN FIB-SEM system

### 11. Renesas Engineering Services Co., Ltd: (C3)

Introduction of reliability evaluation and fault localization analysis services

### 12. Nano Tech Solutions Inc.:

Pulse Laser based Sample Preparation microPREP PRO

### 13. Semilab Japan:

Defect Inspection Tool En-Vision

### 14. Oki Engineering Co., Ltd.: (C4)

The New Failure Analysis System using Lock-In Thermal Emission

### 15. Kobelco Research Institute, Inc.: (C7)

Applications of Laser-Raman Spectroscopy for Semiconductors

### 16. TOKI COMMERCIAL CO., LTD.: (C1)

New Concept of Nano-Probing System

### 17. HIGHTEC SYSTEMS CORPORATION:

JACO MIP Decapsulation System & Neocera Magma MFI For Failure Analysis

## 22 List of Associate Members

(in alphabetic order, 9 November 2020)

- Aamilia Japan G.K.
- AD Science Co.
- ADVANTEST CORPORATION
- AITRANS corporation
- Applied Materials, Inc.
- ASTRON Inc.
- ATE Service Corp.
- Atomicscale Electromagnetic Field Analysis Platform
- Canon Marketing Japan Inc.
- Carl Zeiss Co.,Ltd.
- FEI Company Japan Ltd.
- Hamamatsu Photonics K.K.
- HiSOL, INC.
- Hitachi High-Tech Science Corporation
- Hitachi High-Tech Corporation
- Hightec Systems Corp.
- ITES CO., Ltd.
- JEOL Ltd.
- KOBELCO RESEARCH INSTITUTE, INC.
- MARUBUN CORPORATION
- Nano Tech Solutions Inc.
- NIKON INSTECH CO., LTD.
- Nippon BARNES Company, Ltd.
- Nippon Scientific Co., Ltd
- Oki Engineering Co., Ltd.
- Park Systems Japan Inc.
- Renesas Engineering Services, Co., Ltd.
- Semilab Japan
- Shining Technology Corporation
- TASMIT, Inc.
- Toki Commercial Co., Ltd.
- TOOL CORPORATION
- Toshiba Nanoanalysis Corporation
- TOYO Corporation
- YXLON International K.K.