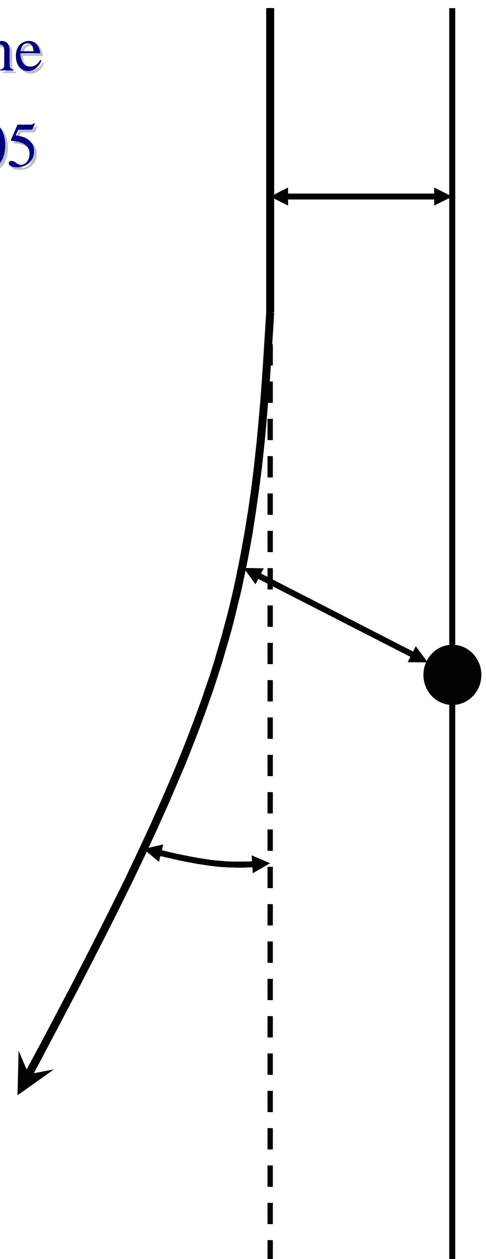
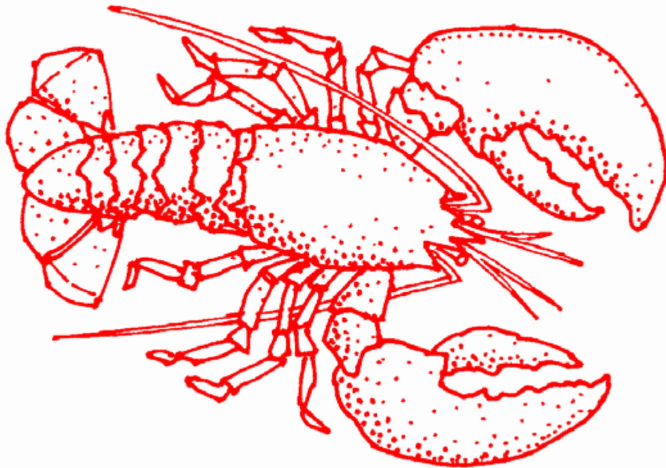
International Workshop on High Resolution Depth Profiling

Bar Harbor, Maine

May 23 - 26, 2005





Conference Chairs

Prof. Torgny Gustafsson
Department of Physics and Astronomy
Rutgers University, Piscataway, NJ 08854

Dr. Matt Copel
IBM T.J. Watson Research Center
P.O. Box 218, Yorktown Heights, NY 10598

International Advisory Committee

Paul Bailey - Daresbury, UK
Matt Copel - Yorktown Heights, US
John O'Connor - Newcastle, Australia
Torgny Gustafsson - Piscataway, US
Yoshiaki Kido - Shiga, Japan
Kenji Kimura - Kyoto, Japan
Takanori Koshikawa - Osaka, Japan
Dae Won Moon - Taejon, Korea
Phil Woodruff - Warwick, UK

Local Organizing Committee

Matt Copel - IBM Research Division
Eric Garfunkel - Rutgers University
Lyudmila Goncharova - Rutgers University
Evgeni Gusev - IBM Research Division
Torgny Gustafsson - Rutgers University
Leszek Wielunski - Rutgers University

We would like to welcome the participants to the workshop, and thank them for contributing to this meeting. This is the third workshop on high resolution depth profiling with ion beams. It follows two successful meetings held in Abingdon, UK (2000) and Kwongju S. Korea (2002). One of the things that made the preceding workshops valuable was the informal exchange of ideas between groups. We hope that this week also allows open discussions not only about achievements, but also difficulties, opportunities and new developments.

The MEIS community has been benefited from a willingness to freely discuss "inside" information. As a result, new groups have been able to thrive. We very much hope that this will continue.

The workshop includes research on a wide variety of subjects. This is not only stimulating, but also a sign of vitality in the community. We expect to learn a great deal this week about techniques and new materials systems. Please feel free to contact us if there is anything we can do to make this a more productive meeting.

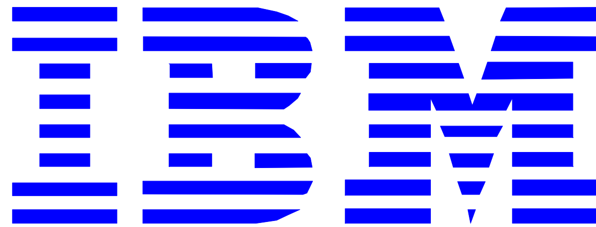
Matt Copel and Torgny Gustafsson

Conference Co-Chairs

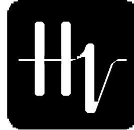
Conference Sponsors

THE STATE UNIVERSITY OF NEW JERSEY

RUTGERS



IBM Research Division



HIGH VOLTAGE ENGINEERING EUROPA B.V.

The largest and most diverse manufacturer of particle accelerators:

- Air Insulated Accelerator Systems up to 500 kV
- Tandetron Accelerator Systems up to 6.0 MV/TV
- Singletron Accelerator Systems up to 6.0 MV/TV
- Research Ion Implanters 10 – 40 MeV and higher
- Systems for RBS-C, PIXE, PIGE, NRA, ERD and MEIS
- Accelerator Mass Spectrometer Systems
- Systems for μ-beam Applications
- Neutron Generators, DC and Pulsed Beam Systems
- Electron Accelerator Systems up to 6.0 MV/50 kW

Amsterdamseweg 63, 3812 RR Amersfoort, P.O. Box 99
3800 AB Amersfoort, The Netherlands
Phone: +31 33 4619741 Fax: +31 33 4615291
E-mail: info@highvolteng.com / Web: www.highvolteng.com

KOBELCO

NEW

World's First Small-Footprint Type

Vertical Type High resolution RBS System!

Ultra-compact! Unsurpassed Depth Resolution! High Performance Spec.!

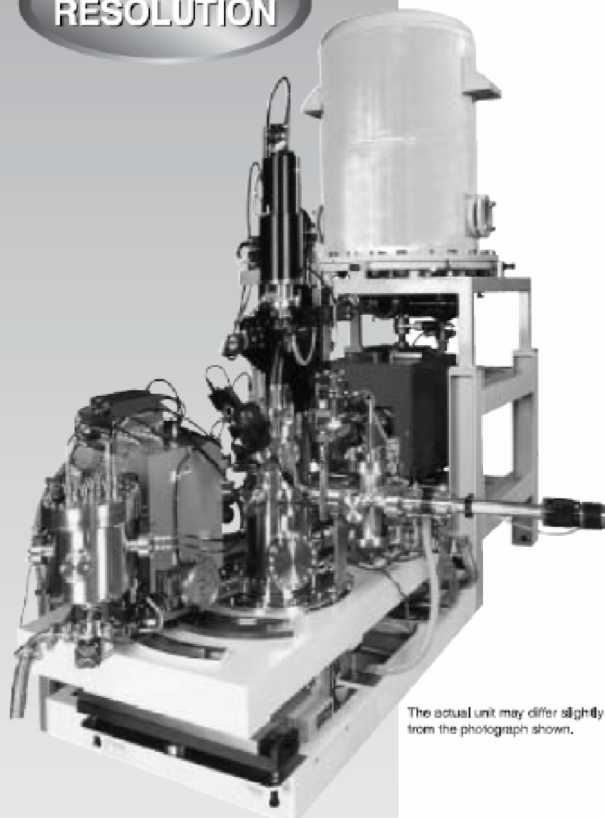
2Å

Innovative Analysis Technique Responding to Nanometric Technology

Vertical Type Rutherford Back Scattering Spectrometry

HRBS-V500

HIGH RESOLUTION



The actual unit may differ slightly from the photograph shown.

☐ Features

Vertical Type! Compact-in-class!

Installation area is reduced by a large margin! (2/3)
Function of hardware and software is upgraded and user-friendly.

Scattering angle is changeable easily all the time! (Option)

Scattering angle can be selected and adjusted without venting vacuum chamber.
Easy operation corresponding to fine adjustment of scattering angle.

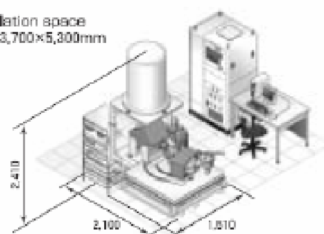
Hydrogen Measurement with High Resolution! (Option)

Hydrogen can be also analyzed with high resolution of 2.8 Å that was impossible to achieve by conventional ERDA.

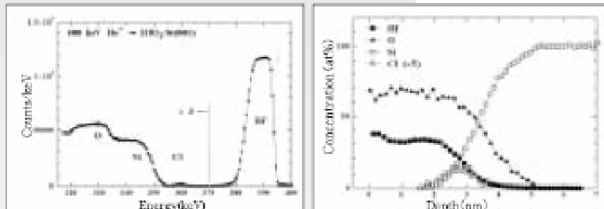
Also Useful for Strain measurement of crystalline!

Strain and crystallinity can be quantitative assessed with high resolution using channeling.

● HRBS-V500 Equipment size



● HRBS Spectrum and Depth profile of High-k (HfOx) film*



※Source: K.Kimura *et al.*, Appl. Phys. Lett., 83, 296 (2003)

Part of the accelerator development was undertaken by the support of NEDO* project.
*New Energy and Industrial Technology Development Organization

KOBE STEEL, LTD.

MACHINERY & ENGINEERING COMPANY

Advanced Products & Technologies Dept.

Tokyo Office
Tel:81-3-5739-6760 Fax:81-3-5739-6990
9-12, 5-chome, Kitashinagawa, Shinagawa-ku, Tokyo, 141-8688 JAPAN

Takasago Office
Tel:81-794-45-7783 Fax:81-794-45-7787
3-1, 2-chome, Shinhama, Arai-cho, Takasago, Hyogo, 676-8670 JAPAN
URL : http://www.kobelco.co.jp/technobook/p238_e.htm

PROGRAM

May 23rd (Monday morning)

<table>
<tr><td>9:00 - 9:15</td><td colspan="2">OPENING</td></tr>
<tr><td>9:15 - 10:00</td><td rowspan="2">Session A:
J. O’Connor
(chair)</td><td>Issues and Opportunities and the Organic/Inorganic Interface (invited)
R. Tromp</td></tr>
<tr><td>10:00 - 10:45</td><td>Influence of strain on radiation damage studied by high-resolution RBS (invited)
T. Matsushita, K. Nakajima, M. Suzuki, K. Kimura, A. Agarwal, H.-J. Gossmann, and M. Ameen</td></tr>
<tr><td>10:45 - 11:15</td><td colspan="2">COFFEE BREAK</td></tr>
<tr><td>11:15 - 12:00</td><td rowspan="2">Session B:
P. Woodruff
(chair)</td><td>Ultra high resolution heavy ion ERD and its application in the field of future microelectronic materials (invited)
A. Bergmaier and G. Dollinger</td></tr>
<tr><td>12:00 - 12:30</td><td>Transport and exchange of hydrogen isotopes in silicon-device-related stacks
E. P. Gusev, C. Krug, E. Cartier and T. Zabel</td></tr>
<tr><td>12:30 - 14:00</td><td colspan="2">LUNCH</td></tr>
</table>

May 23rd (Monday afternoon)

14:00 - 14:45	Session C: L. Feldman (chair)	**High resolution profiling using nuclear resonant reactions and medium energy ion scattering** (invited) I. J. R. Baumvol and R. P. Pezzi
14:45 - 15:15		**Epitaxial Oxide Films Grown on Si Studied by Medium Energy Ion Scattering** L. V. Goncharova, D. Starodub, E. Garfunkel and T. Gustafsson
15:15 - 15:45	COFFEE BREAK	
15:45 - 16:30	Session D: D. W. Moon (chair)	**Ab-initio calculations of the surface peak** (invited) P. L. Grande, A. Hentz, and G. Schiwietz
16:30 - 17:00		**Absolute Yield Measurements in the Medium Energy Regime** P. Bailey and T. C. Q. Noakes

17:00 – 18:00 Poster session		**Initial stage of Pd adsorption on Ni(111) studied by low energy ion scattering** K. Umezawa, S. Nakanishi, and W. M. Gibson **Trends in the structures of two-dimensional rare earth silicides on Si(111) investigated using medium-energy ion scattering** T. J. Wood, I.M. Scott, D.J. Spence, C. Bonet, T. C. Q. Noakes, P. Bailey and S. P. Tear **Medium-energy ion scattering investigation of neodymium silicide on Si(111)** T. J. Wood , C. Bonet, T. C. Q. Noakes , P. Bailey and S. P. Tear **Medium-energy ion scattering investigation of two-dimensional YSi_2 grown on Si(111)** T. J. Wood, C. Bonet, T. C. Q. Noakes, P. Bailey and S. P. Tear **Interfacial Characteristics of High Dielectric Thin Films By Means of MEIS Analysis** M.-H. Cho, K. B. Chung, D. W. Moon, D. W. Lee, D.-H. Ko, and C. N. Whang **Adsorption structure determination of C_2H_4 on Si(001) surface by low-energy ion-scattering spectroscopy** K. H. Chae, J. H. Seo, J. Y. Park, C. N. Whang, S. S. Kim, and D. S. Choi

May 24th (Tuesday morning)

<table>
<tr><td>9:00 - 9:45</td><td rowspan="2">Session E:
P. Bailey
(chair)</td><td>Surface Structure Analysis by Low and Medium Energy Ion Scattering (invited)
Y. Kido, Ritsumeikan University</td></tr>
<tr><td>9:45 - 10:30</td><td>MEIS as a probe of Adsorbate Induced Segregation at Bimetallic Surfaces (invited)
T. E. Jones, T. G. Owens, A. Trant, C. J. Baddeley,
T. C. Q. Noakes and P. Bailey</td></tr>
<tr><td>10:30 - 11:00</td><td colspan="2">COFFEE BREAK</td></tr>
<tr><td>11:00 - 11:45</td><td rowspan="3">Session F:
M. Copel
(chair)</td><td>Probing Surface Reconstructions with MEIS (invited)
D. P. Woodruff, M. A. Muñoz-Márquez,
G. S. Parkinson, P. D. Quinn and M. Gladys</td></tr>
<tr><td>11:45 - 12:15</td><td>Surface Structure of Sphalerite with MEIS
R. Kolarova, S. Harmer, L. Goncharova, W. N. Lennard,
M. A. M. Marquez, H. W. Nesbitt and I. V. Mitchell</td></tr>
<tr><td>12:15 – 12:45</td><td>Medium-energy ion scattering investigation of three-dimensional holmium silicide grown on Si(111).
T. J. Wood, C. Bonet, T. C. Q. Noakes, P. Bailey
and S. P. Tear</td></tr>
<tr><td>12:45 - 14:00</td><td colspan="2">LUNCH</td></tr>
</table>

May 24th (Tuesday afternoon)

Time	Session	Presentation
14:00 - 14:45	Session G: Y. Kido (chair)	**The application of high resolution ion scattering to aperiodic quasicrystalline materials** (invited) T. C. Q. Noakes, P. Bailey, J. Smerdon, J. Ledieu, R. McGrath, C. F. McConville, C. R. Parkinson, A. R. Ross and T. A. Lograsso
14:45 - 15:30		**Diffusion in Surface Alloys and Quasicrystals** (invited) D. J. O'Connor, Y. G. Shen, M. Gladys, F. Samavat, L. Zhu, B. V. King, A. Hoffman
15:30 – 16:00	COFFEE BREAK	
16:00 - 16:30	Session H: W. N. Lennard (chair)	**Development of a low energy atom scattering system** K. Umezawa, S. Nakanishi, E. Narihiro, K. Oda, and W. M. Gibson
16:30 - 17:00		**Thermal activation of As implanted in bulk-Si and SIMOX** M. Dalponte, H. Boudinov, L. V. Goncharova, D. Starodub, E. Garfunkel and T. Gustafsson
17:00 – 17:30		**Damage Accumulation and Dopant Migration during Shallow As and Sb Implantation into Si** J. A. van den Berg, M. Werner, D. G. Armour, P. Bailey and T. C. Q. Noakes
17:30 – 18:00		**Development of three-dimensional medium-energy ion scattering** T. Kobayashi and S. Shimoda

May 25th (Wednesday)

Time	Session	Presentation
9:00 - 9:45	Session I: I. Baumvol (chair)	**In-situ MEIS studies on the initial growth stage of gate dielectric thin films** (invited) Dae Won Moon and Man-ho Cho
9:45 - 10:30		**Composition and diffusion in high-K dielectric films** (invited) L. Goncharova, D. Starodub, R. Barnes, T. Gustafsson, E. Garfunkel, G. Bersuker, B. Foran, and P. Lysaght
10:30 - 11:00	COFFEE BREAK	
11:00 - 11:45	Session J: K. Kimura (chair)	**Materials interactions of metal oxide dielectrics** (invited) Matt Copel
11:45 - 12:15		**Pressure dependence of NH_3 Nitridation of HfO_2 and Hafnium Silicates thin films** J.-J. Ganem, I. Trimaille and E. P. Gusev
12:15 - 12:45		**Depth Distribution Measurements of N and O in Ultrathin Silicon Oxynitrides** W. N. Lennard, L. Goncharova, G. Mount and R. Kolarova
12:45 - 14:00	LUNCH	
14:00 - 18:00	EXCURSION	
19:00 – 21:00	CONFERENCE DINNER	

May 26th (Thursday)

Time	Session	Presentation
9:00 - 9:45	Session K: E. Garfunkel (chair)	**Semiconductor-Dielectric Interfaces: Interface Composition and Structure** (invited) L. C. Feldman, S. Dhar, J. R. Williams, L. Porter, J. Bentley, K.-C. Chang, and Y. Cao
9:45 - 10:15		**Synthesis and Characterization of Oxide Electrolyte Nanostructures for Fast Oxygen Ionic Conduction** V. Shutthanandan, S. Thevuthasan, L. Saraf, S. Azad, O. A. Marina, M. Engelhard, C.M. Wang, Y. Zhang, A. El-Azab, and P. Nachimuthu
10:15 - 10:45	COFFEE BREAK	
10:45 - 11:15	Session L: P. Grande (chair)	**Thermal annealing effect on InAs/GaAs quantum dots studied by ion channeling** H. Niu, C.H Chen, H.Y Wang, S.C. Wu and C. P. Lee
11:15 -11:45		**High sensitivity RBS detection of Carbon and Oxygen in ultra-thin HfO_2 films deposited on Silicon by Atomic Layer Deposition technique.** L. S. Wielunski, Y. J. Chabal, Y. Wang, M.-T. Ho and J. E. Reyes