



E-MRS Spring Meeting 2001
June 5 - 8, 2001

SYMPOSIUM Q

High-k Gate Dielectrics

Symposium Organizers:

Marco Fanciulli, Laboratory MDM – INFM, Agrate Brianza, Italy

Suvi Haukka, ASM Microchemistry Ltd., Espoo, Finland

Michel Houssa, University of Leuven and IMEC, Leuven, Belgium

Edward W.A. Young, Philips Research, Eindhoven, The Netherlands

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E-MRS 2001 SPRING MEETING

SYMPOSIUM Q

Tuesday, June 5, 2001
Mardi 5 juin 2001

Morning
Matin

Session I: Oxides and Oxynitrides
Session Chair: G. Lucovsky

- Q-I.1** 08:30 INTERFACE ENGINEERING OF PHOTO ELECTROCHEMICALLY PREPARED Si SURFACES, D. Schmeißer(a), M. Aggour(b), H.Jungblut(b), H.J. Lewerenz(b), Chr. Murrell(b), P. Hoffmann(a), R.P. Mikalo(a), (a)BTU Cottbus, Lehrstuhl Angewandte Physik II / Sensorik, Erich-Weinert-Str. 1, 03046 Cottbus, Germany, (b)Hahn-Meitner-Institut, Sektion SE5, Glienicker Straße 100, 14109 Berlin, Germany
- Q-I.2** 08:50 ELECTRICAL AND CHEMICAL PROPERTIES OF RAPID-THERMAL-PROCESSED ULTRA-THIN SILICON OXYNITRIDE AND SILICON OXIDE, J. S. Kim, H. W. Yeom, S. Im, Institute of Physics and Applied Physics, Yonsei Univ., Seoul, 120-749, Korea
- Q-I.3** 09:10 A PRAGMATIC APPROACH TO THE QUANTIFICATION NITROGEN IN THIN GATE OXYNITRIDES USING SIMS AND NUCLEAR REACTION ANALYSIS, G.A. Cooke, H. Kheyrandish, S. Romani, MATS Daten Park, Birchwood, Warrington WA3 6UT, UK, J. Kelly and M.G. Dowsett, Dept. of Physics, University of Warwick, Coventry CV4 7AL, UK
- Q-I.4** 09:30 Si(001) SURFACE OXIDATION BY N₂O, P. Hoffmann, R.P. Mikalo, D. Schmeißer, BTU Cottbus, Lehrstuhl Angewandte Physik II / Sensorik, Erich-Weinert-Str. 1, 03046 Cottbus, Germany
- Q-I.5** 09:50 EFFECT OF BARIUM CONTAMINATION ON GATE OXIDE INTEGRITY IN HIGH-k DRAM, H. Boubekeur(a), T. Mikolajick(a), C. Dehm(a), A. Bauer(b), L. Frey(2,3), H. Ryssel (2,3), (a)Infineon Technologies, (b)Fraunhofer Institute of Integrated Circuit, IIS-B, (c)Lehrstuhl für Elektronische Bauelemente, Germany
- 10:10 **BREAK**

Session II: ALCVD of high k dielectrics– deposition and characterization
Session Chair: W.F.A. Besling

- Q-II.1** 10:40 -Invited- ATOMIC LAYER DEPOSITION OF THIN OXIDE FILMS, **M. Ritala**, University of Helsinki, Department of Chemistry, P.O. Box 55, 00014 University of Helsinki, Finland
- Q-II.2** 11:10 INTERFACE AND MATERIAL CHARACTERISATION OF THIN Al₂O₃ LAYERS DEPOSITED BY AID USING TMA/H₂O PRECURSORS, **L.G. Gosset**, J.-F. Damlencourt, O. Renault, D. Rouchon, Ph. Holliger, A. Ermolieff, F. Martin and M.-N. Séméria, LETI (CEA-Grenoble), 17 avenue des Martyrs, 38054 Grenoble Cedex 9, France, J.-J. Ganem and I. Trimaille, Groupe de Physique des Solides, Tour 23, 2 place Jussieu, 75251 Paris Cedex 05, France
- Q-II.3** 11:30 ATOMIC LAYER DEPOSITION OF ZrO₂ THIN FILMS USING NEW ALKOXIDE PRECURSORS, A.C. Jones, P.A. Williams, **T.J. Leedham**, H.O. Davies, Inorgtech Limited, 25 James Carter Road, Mildenhall, Suffolk, IP28 7DE, UK and R. Matero, M. Ritala, M. Leskelä, Department of Chemistry, PO Box 55, University of Helsinki, 00014 Helsinki, Finland
- Q-II.4** 11:50 STRUCTURAL AND ELECTRICAL CHARACTERIZATION OF ALCVD ZrO₂ THIN FILMS ON SILICON, **S. Ferrari**, S. Spiga, G. Tallarida, C. Wiemer and M. Fanciulli, Laboratorio MDM – INFN, Via Olivetti 2, 20041 Agrate Brianza (Mi), Italy
- Q-II.5** 12:10 ATOMIC LAYER DEPOSITION OF Al₂O₃, ZrO₂, Ta₂O₅ AND Nb₂O₅ BASED NANOLAYERED DIELECTRICS, **K. Kukli**, M. Ritala and M. Leskelä, University of Helsinki, Department of Chemistry, P.O. Box 55, 00014 University of Helsinki, Finland
- 12:30 **LUNCH**

Tuesday, June 5, 2001
Mardi 5 juin 2001

Afternoon
Après-midi

Session III: Physical and electrical characterization of medium k gate dielectrics

Session Chair: V.V. Afanas'ev

- Q-III.1** 14:00 -Invited- CORRELATIONS BETWEEN ELECTRONIC STRUCTURE OF TRANSITION METAL ATOMS AND PERFORMANCE OF HIGH-k GATE DIELECTRICS IN ADVANCED Si DEVICES, **G. Lucovsky**, Dept. of Physics, NC State University, Raleigh, NC 27695-8202, USA
- Q-III.2** 14:30 CONTRIBUTION OF AMORPHOUS CHARACTER OF THIN TITANIUM DIOXIDE FILMS TO INFRARED SPECTRA, **G. Scarel**, Department of Materials Engineering, University of Wisconsin-Milwaukee, P.O. Box 784, Milwaukee WI 53201, USA, H. Tanaka and K. Hisano, Department of Applied Physics, The National Defense Academy, Yokosuka 239, Japan
- Q-III.3** 14:50 DIRECT EPITAXY OF CRYSTALLINE Y2O3 ON SILICON FOR HIGH-k GATES, **A. Dimoulas**, G. Vellianitis and A. Travlos Institute of Materials Science, National Center for Scientific Research "DEMOKRITOS", Athens, Greece
- Q-III.4** 15:10 EXPERIMENTAL OBSERVATIONS OF THE THERMAL STABILITY OF HIGH-K GATE DIELECTRIC MATERIALS ON SILICON, **P.S. Lysaght**, R. Bergmann, J. Chen, T. Messina, R. Murto, D. Sing and H.R. Huff, International SEMATECH, 2706 Montopolis Drive, Austin Texas 78741-6499, USA
- Q-III.5** 15:30 ELECTRONIC AND STRUCTURAL PROPERTIES OF Ta₂O₅ THIN FILMS DEPOSITED ON Si(100) FROM Ta(OC₂H₅)₅ PRECURSOR, **M. Passacantando**, L. Lozzi, P. Picozzi, V. Salerni and S. Santucci, Department of Physics and Unita INFN, University of L'Aquila, 67100 L'Aquila, Italy
- Q-III.6** 15:50 MOCVD OF TITANIUM DIOXIDE ON THE BASIS OF NEW PRECURSORS, **T. Leistner**, K. Lehmacher, P. Härter, A. Bauer, H. Ryssel, Universität Erlangen, Lehrstuhl für Elektronische Bauelemente, Erlangen, Germany
- 16:10 **BREAK**

Session IV: Band alignment of high k dielectrics with Si: measurement and impact on electrical properties

Session Chair: J. Robertson

- Q-IV.1** 16:40 -Invited- BAND ALIGNMENT AT THE INTERFACES OF Al_2O_3 AND ZrO_2 -BASED INSULATORS WITH METALS AND Si, **V.V. Afanas'ev**, M. Houssa, A. Stesmans, and M. M. Heyns*, Department of Physics, University of Leuven, Celestijnenlaan 200 D, 3001 Leuven, Belgium, *IMEC, Kapeldreef 75, 3001 Leuven, Belgium
- Q-IV.2** 17:10 ELECTRICAL PROPERTIES OF Al_2O_3 FILM FABRICATED AT LOW TEMPERATURES, W.H. Ha, Department of Metallurgical Engineering, Yonsei Univ., Seoul 120-749, Korea, S.P. Park, **S. Im**, Institute of Physics and Applied Physics, Yonsei Univ., Seoul 120-749, Korea
- Q-IV.3** 17:30 INTERFACE PROPERTIES OF RARE EARTH THIN FILM OXIDE-SILICON BARRIER, A.M. Sverdlova, **Y.G. Fedorenko**, Saratov State University, Russia
- Q-IV.4** 17:50 CHARACTERIZATION OF ALCVD- Al_2O_3 AND ZrO_2 LAYER USING X-RAY PHOTOELECTRON SPECTROSCOPY, **H. Nohira**, W. Tsai, W. Besling, E. Young, J. Petry, T. Conard, W. Vandervorst, S. De Gendt, M. Heyns, IMEC Kapeldreef 75, 3001 Leuven, Belgium and J. Maes, M. Tuominen, ASM Europe, Rembrandtlaan 7-9, 3723 BG Bilthoven, The Netherlands

Wednesday, June 6, 2001
Mercredi 6 juin 2001

Afternoon
Après-midi

Session V: PLD of high k dielectrics and perovskite structures
Session Chair: M. Ritala

Q-V.1 14:00 -Invited- HIGH-K DIELECTRICS GROWN BY PULSED LASER DEPOSITION: GROWTH AND INTERFACE STUDIES, **D.H.A. Blank**, MESA+ research institute, Dept. of Applied Physics, Low Temperature Division, University of Twente, The Netherlands

Q-V.2 14:30 CONTROL OF DIELECTRIC PROPERTIES OF ZrTiO₄ THIN FILMS, **B.E. Watts**, F. Leccabue, Istituto MASPEC/CNR, 43100 Parma; G. Gusmano, A. Bianco, M. Viticoli, Dipto. di Scienze e Tecnologie Chimiche, Università di Roma, S. Kaciulis, G. Mattogno, G. Padeletti, L. Pandolfi, ICMAT/CNR, Area della Ricerca di Montelibretti, Roma, Italy

Q-V.3 14:50 DIELECTRIC PROPERTIES OF Zr-Sn-Ti-O THIN FILMS PREPARED BY PULSED LASER DEPOSITION, X.B. Lu, Y.P. Wang, H.Q. Ling and **Z.G. Liu**, National Laboratory of Solid State Microstructures, Nanjing University, Hankou Road 22, Nanjing 210093, China

Q-V.4 15:10 EPITAXIAL OXIDES AS GATE DIELECTRICS: GROWTH AND CHARACTERIZATION OF CUBIC OXIDES, **J. Fompeyrine**(a), J.W. Seo(a,b), H. Siegart(a) J.-P. Locquet(a), (a)IBM Research Division, Zurich Research Laboratory, 8803 Ruschlikon, Switzerland, (b)Institut de Physique, Université de Neuchâtel, 2000 Neuchâtel, Switzerland

15:30 **BREAK**

16:00-18:00 **Pannel Discussion**

Chair: M. Stoneham
Moderators: E. Young, G. Lukovsky, ...

Thursday, June 7, 2001
Jeudi 7 juin 2001

Morning
Matin

Session VI: Theory and Modelling of high k dielectrics
Session Chair: M. Fanciulli

- Q-VI1** 08:30 -Invited- BAND ALIGNMENTS OF GATE OXIDES WITH HIGH DIELECTRIC CONSTANTS, **J. Robertson**, Engineering Dept, Cambridge University, Cambridge CB2 1PZ, UK
- Q-VI2** 09:00 OXYGEN DIFFUSION IN HIGH-k DIELECTRICS, A.S. Foster and R.M. Nieminen
Laboratory of Physics, Helsinki University of Technology, P.O.Box 1100, 02015 HUT, Finland
- Q-VI3** 09:20 NON LINEAR DIELECTRIC PROPERTIES OF METAL-TANTALUM PENTOXIDE-METAL STRUCTURES, S. Blonkowski, M. Regache and A. Halimaoui, STMicroelectronics, 850 rue Jean Monnet, 38926 Crolles Cedex, France
- Q-VI4** 09:40 -Invited- WHY MODEL HIGH-k DIELECTRICS?, **A.M. Stoneham**, Centre for Materials Research, Department of Physics and Astronomy, University College London, London WC1E 6BT, UK
- 10:10 **BREAK**

Session VII: Microstructural analysis of high k dielectrics
Session Chair: R. Ludeke

- Q-VII.1** 10:40 -Invited- CHARACTERIZATION OF ALCVD Al₂O₃-ZrO₂ NANOLAMINATES, LINK BETWEEN ELECTRICAL AND STRUCTURAL PROPERTIES, **W.F.A. Besling**, Philips Research Leuven, Kapeldreef 75, 3001 Leuven, Belgium
- Q-VII.2** 11:10 NANOCRYSTALLINE TiO₂ FILMS STUDIED BY OPTICAL, XRD AND FTIR SPECTROSCOPY, **J.-Y. Zhang** and I.W. Boyd, Electronic & Electrical Engineering, University College London, Torrington Place, London WC1E 7JE, UK, B.J. O'Sullivan, P.K. Hurley, P.V. Kelly, National Microelectronics Research Centre, Lee Maltings, Prospect Row, Cork, Ireland, J.-P. Senateur, Institut National Polytechnique de Grenoble, École Nationale Supérieure de Physique de Grenoble - LMGP, B.P. 46,
- Q-VII.3** 11:30 A STUDY OF THE MICROSTRUCTURE AND ELECTRICAL PROPERTIES OF HfO₂ THIN FILMS UPON SURFACE TREATMENTS, **S-W Nam**, J-H Yoo, M-J Kim, D-H Ko, Dept. of Ceramic Engineering, Yonsei Univ., Seoul, Korea, and J-H Ku, Siyoung Choi, Samsung Electronics Co., Ltd. and C-W Yang, Sungkyunkwan University, Korea
- Q-VII.4** 11:50 CRYSTALLIZATION BEHAVIOUR OF ZrO₂/Al₂O₃-BASED HIGH-K GATE STACKS, **C. Zhao**, O. Richard, H. Bender, M. Houssa, R. Carter, S. Degendt and M. Heyns, IMEC, Kapeldreef 75, 3001 Leuven, Belgium; E. Youg (P.R.) and W. Tsai (Intel), INTERNATIONAL SEMATECH Residents, IMEC, Kapeldreef 75, 3001 Leuven, Belgium; G. Roebben and O. Van Der Biest, MTM K.U. Leuven, De Croylaan 2, 3001 Leuven, Belgium; S. Haukka, ASM Microchemistry Ltd., Kutojantie 2B, 02631 Espoo, Finland
- Q-VII.5** 12:10 INTEGRATED IN-LINE PROCESS CONTROL BY XPS IN A CLUSTER TOOL, **A. Schröder-Heber**, M. Schellenberger, Ch. Schmidt, C. Schneider, L. Pfitzner, and H. Ryssel, Fraunhofer Institut für Integrierte Schaltungen, Schottkystrasse 10, 91058 Erlangen, Germany
- 12:30 **LUNCH**

Thursday, June 7, 2001
Jeudi 7 juin 2001

Afternoon
Après-midi

Session VIII: Local structure of high k dielectrics and defect characterization
Session Chair: M. Stoneham

- Q-VIII1** 14:00 -Invited- ELECTRICAL CHARACTERIZATION OF GATE OXIDES BY SCANNING PROBE MICROSCOPES, **R. Ludeke**, IBM T.J. Watson Research Center, P.O. Box 218, Yorktown Heights NY 10598, USA
- Q-VIII2** 14:30 SUBMICRON CHARGE STORAGE IN OXIDE/NITRIDE/OXIDE GATE STRUCTURES, G. Lubarsky, R. Shikler, N. Ashkenasy, and Y. Rosenwaks, Department of Physical Electronics, Faculty of Engineering, Tel-Aviv University, Ramat-Aviv 69978, Israel
- Q-VIII3** 14:50 ELECTRON SPIN RESONANCE ANALYSIS OF INTERFACIAL Si DANGLING BOND TYPE DEFECTS IN STACKS OF ULTRATHIN SiO₂, Al₂O₃, AND ZrO₂ LAYERS ON (100)Si, A. Stesmans and V. Afanas'ev, Department of Physics, University of Leuven, 3001 Leuven, Belgium
- Q-VIII4** 15:10 ELECTRICAL CHARACTERIZATION OF THIN OXIDE FILMS USING ATOMIC FORCE MICROSCOPY, P. De Wolf, Veeco Instruments, 11 rue Marie Poussepin, 91412 Dourdan, France
- Q-VIII5** 15:30 CHARACTERIZATION OF ULTRATHIN GATE DIELECTRICS BY GRAZING X-RAY REFLECTANCE AND VUV SPECTROSCOPIC ELLIPSOMETRY ON THE SAME INSTRUMENT, P. Boher, P. Evrard, J.-P. Piel and J.-L. Stehle, SOPRA S.A., 26 rue Pierre Joigneaux, 92270 Bois-Colombes, France
- Q-VIII6** 15:50 AN ELECTRON PARAMAGNETIC RESONANCE STUDY OF THE Si(100)/Al₂O₃ INTERFACE DEFECTS, J.L. Cantin, H.J. von Bardeleben, GPS, University Paris 6&7, 2 place Jussieu, 75005 Paris, France
- 16:10 **BREAK**

Session IX: Very high k dielectrics
Session Chair: D.H.A. Blank

- Q-IX.1** 16:40 CHARACTERIZATION OF $\text{Ba}_x\text{Sr}_{1-x}\text{TiO}_3$ FILMS USING SPECTROSCOPIC ELLIPSOMETRY, RUTHERFORD BACKSCATTERING SPECTROSCOPY AND X-RAY DIFFRACTION, P. Petrik, N.Q. Khanh, Z.E. Horvath, Z. Zolnai, I. Barsony, T. Lohner, M. Fried, J. Gylai, Research Institute for Technical Physics and Materials Science, 1525 Budapest, P.O. Box 49, Hungary, C. Schmidt, C. Schneider, Fraunhofer-Institut für Integrierte Schaltungen, Schottkystrasse 10, 91058 Erlangen, Germany, H. Ryssel, Lehrstuhl für Elektronische Bauelemente, Friedrich-Alexander Universität Erlangen-Nürnberg, Cauerstrasse 6, 91058 and Fraunhofer-Institut für Integrierte Schaltungen, Schottkystrasse 10, 91058 Erlangen, Germany
- Q-IX.2** 17:00 ELECTRICAL CHARACTERIZATION OF SrTiO_3/Si INTERFACES, N. Konofaos, E.K. Evangelou, Applied Physics Laboratory, Department of Physics, University of Ioannina, 451 10 Ioannina, Greece, Zhongchun Wang, V. Kugler and U. Helmerson, Department of Physics, Linköping University, 581 83 Linköping, Sweden
- Q-IX.3** 17:20 CHARACTERIZATION OF BARIUM ZIRCONATE TITANATE THIN FILMS DEPOSITED BY RF MAGNETRON SPUTTERING, W. Choj, B. Jang, J. Yi, and B. Hong, School of Electrical and Computer Engineering, Sungkyunkwan University, Suwon 440-746, Korea
- Q-IX.4** 17:40 STRUCTURAL STUDY OF $(\text{BaTiO}_3/\text{SrTiO}_3)_N$ SUPERLATTICES BY MEANS OF SYNCHROTRON X-RAY DIFFRACTION AND REFLECTIVITY, E. Dooryhée, C. Dubourdieu, F. Weiss, J-P. Sénateur, J-L. Hodeau, J-F. Bézar, H. Roussel, Laboratoire de Cristallographie CNRS, Grenoble, France, Laboratoire des Matériaux et du Génie Physique, INPG, ENS de Physique, Grenoble, France
- Q-IX.5** 18:00 CRYSTALLINE AND ELECTRICAL PROPERTIES OF PULSED LASER DEPOSITED BST ON PLATINUM SUBSTRATES, L. Goux, STMicroelectronics, 16 rue Pierre et Marie Curie, BP7155, 37071 Tours Cedex2, France, M. Gervais, LEMA, Faculté des Sciences et Techniques, Parc de Grandmont, 37000 Tours, France, A. Catherinot and C. Champeaux, SPCTS, Faculté des Sciences, 123 Avenue A. Thomas, 87060 Limoges Cedex, France, F. Sabary, CEA Le Ripault, BP16, 37260 Monts, France