SYMPOSIUM ON ULTRA CLEAN PROCESSING OF SEMICONDUCTOR SURFACES 2021
PROGRAM
all presentations: online
(Time: UTC+2h)

Tuesday 13 April 2021

WELCOME AND OPENING 08:20 – 08:40

08:20 - 08:40  1.1 - Welcome and opening address

Paul Mertens
imec, Belgium

SESSION 1 - FEOL: ETCHING OF GROUP IV SEMICONDUCTORS 08:40 – 09:20

Chair: Kurt Wostyn  imec
Co-Chair: Takahashi Hiroaki  SCREEN

08:40 - 09:00  1.1 - Reaction Kinetics of Poly-Si Etching in TMAH Solution (student presentation)

Park, Taegun, Lim, Sangwoo
Yonsei University, Republic of Korea

09:00 – 09:20  1.2 - Surface Chemistry and Nanoscale Wet Etching of Group IV Semiconductors in Acidic H2O2 Solutions

van Dorp, Dennis
imec, Belgium

SESSION 2 - FEOL: ETCH DIELECTRIC FILMS & REMOVAL OF MASKING FILMS 09:20 – 10:40

Chair: Martin Knotter  NXP Semiconductors
Co-Chair: Nasser Belmiloud  SCREEN

09:20 – 09:40  2.1 Highly Selective Etching between Different Oxide Films by Vapor Phase Cleaning

Nishihara, Kazuki; Inaba, Masaki; Takahashi, Hiroaki
SCREEN Semiconductor Solutions Co., Ltd., Japan

09:40 – 10:00  2.2 - Kinetic Study on the Si3N4 Etching in Superheated Water (student presentation)

Son, Changjin; Lim, Sangwoo
Yonsei University, Republic of Korea

10:00 – 10:20  2.3 - Silicon Corrosion during Selective Silicon Nitride Etch with Hot Diluted Hydrofluoric Acid

Garnier, Philippe (1); Massin, Thomas (1); Chatelet, Corentin (1); Oghdayan, Emmanuel (1); Lauerhaas, Jeffrey (2); Morote, Carlos (2); Butterbaugh, Jeffery (2)
1. STMicroelectronics, France; 2. TEL Manufacturing and Engineering of America, Inc, USA
2.4 - High Performance, Eco-Friendly SPM Cleaning Technology Using Integrated Bench-Single Wafer Cleaning System

Henry, Sally Ann (1); Chen, Fuping (1); Wang, David (1); Zhang, Xiaoyan (1); Wang, Wenjun (1); Ren, Shuchao (1); Jia, Shena (1); Wang, Jun (1); Wang, Jane (1); Wang, Xi (1); Tang, Baoguo (1); Lee, Jason (1); Kim, YY (1); Chae, KK (1); Lee, SH (1); Lee, Bruce (1); Lei, Haibo (2); Zhang, Yu (2); Zhang, Tao (2); Huang, Jun (2); Li, Fang (2); Wang, Chunwei (2); Li, Hong (2); Yang, Yi (2)

1: ACM Research (Shanghai), Inc. United States of America; 2: Shanghai Huali Microelectronics corporation

10:40 – 11:00  BREAK

SESSION 3 - CONTAMINATION AND CONTAMINATION CONTROL  11:00 – 13:10

Chair: Gyuhyun Kim  SK HYNIX
Co-Chair: Guy Vereecke  imec

11:00 – 11:20  3.1 - Direct Analysis of Ultra Trace Metallic Particles in NH3 and HCl Gases by GED-ICP-MS

Kawabata, Katsu; Nishiguchi, Kohei; Ichinose, Tatsu
IAS Inc., Japan

11:20 – 11:40  3.2 - Investigation of Contaminants in Single Wafer Wet Cleaning Using Isopropyl Alcohol (student presentation)

Oh, Seungjun (1); Lee, Sunyoung (2); Kim, Heehwan (3)
IAS Inc., Japan

11:40 – 12:00  3.3 - CI-Containing Microplastics from the Environment

Knotter, D. Martin; Sharma, Pradeep; Goumans, Leon
NXP Semiconductors

12:00 – 12:20  3.4 - Experimental Wafer Carrier Contamination Analysis and Monitoring in Fully Automated 300 mm Power Production Lines

Zängle, Clara (1); Pfeffer, Markus (1); Franze, Peter (2); Schneider, Germar (2); Bauer, Anton (1)
1: Fraunhofer Institute of integrated Systems and Device Technology; 2: Infineon Technologies Dresden GmbH & Co. KG

12:20 – 12:40  3.5 - Characterization and Removal of Metallic Contamination in Process Chemicals Using Single Particle Inductively Coupled Plasma Mass Spectrometry (SP-ICP-MS)

Sampath, Siddarth; Maharjan, Kusum; Ozzello, Anthony; Bhabhe, Ashutosh
Entegris, United States of America

12:40 – 13:10  3.6 - Surface Cleaning Challenges for Organic Light Emitting Diodes (invited speaker)

Chris Giebink
Pennsylvania State University, United States of America

13:10 – 13:30  BREAK
SESSION 4 - FEOL: SURFACE CHEMISTRY AND ETCHING OF III-V COMPOUND SEMICONDUCTOR  
13:30 – 15:00

Chair: Dennis Van Dorp imec  
Co-Chair: Harold Philipsen imec

13:30 – 13:50  
4.1 - Analysis of Surface Reaction for Group III-V Compound Semiconductors in Functional Water  
Nishio, Kenya (1); Oinoue, Takashi (1); Saito, Suguru (1); Hagimoto, Yoshiya (1); Ogawa, Yuuichi (2); Ida, Junichi (2); Iwamoto, Hayato (1)  
1: Sony Semiconductor Solutions Corporation, Japan; 2: Kurita Water Industries Ltd.

13:50 – 14:10  
4.2 - Effect of Surface Oxidation on the Material Loss of InGaAs in Acidic Solutions (student presentation)  
Na, Jihoon; Lim, Sangwoo  
Yonsei University, Republic of Korea

14:10 – 14:30  
4.3 - Characterization of Wet Chemical Atomic Layer Etching of InGaAs  
Tomoki, Hirano; Kenya, Nishio; Takashi, Fukatani; Suguru, Saito; Yoshiya, Hagimoto; Hayato, Iwamoto  
Sony Semiconductor Solutions, Japan

14:30 – 15:00  
4.4 - GaN MOS Structures with Low Interface Trap Density (invited speaker)  
Ronming Chu  
Pennsylvania State University, United States of America

15:00 – 15:40  BREAK

SESSION 5 - FEOL: SURFACE PREPARATION OF GROUP IV SEMICONDUCTORS  
15:40 – 16:20

Chair: Jim Snow SCREEN  
Co-Chair: Akshey Seghal INTEL

15:40 – 16:00  
5.1 - Towards Si-Cap-Free SiGe Passivation: Impact of Surface Preparation on Low-Pressure Oxidation of SiGe  
Wostyn, Kurt; Arimura, Hiroaki; Kimura, Yosuke; Hikavyy, Andriy; Rondas, Dirk; Conard, Thierry; Ragnarsson, Lars-Ake; Horiguchi, Naoto  
imec, Belgium

16:00 – 16:20  
5.2 - Wet Chemical Cleaning of Organosilane Monolayers  
Hinckley, Adam; Muscat, Anthony  
University of Arizona, United States of America
## SESSION 6 - WET PROCESSING IN NARROW SPACES AND PATTERN COLLAPSE  08:00 – 10:00

**Chair:** Kuntack Lee  
**Co-Chair:** Sangwoo Lim

### 08:00 – 08:20

**6.1 - Effect of Hydrophobicity and Surface Potential of Siliconon SiO2 Etching in Nanometer-Sized Narrow Spaces**  
Ueda, Dai (1); Hanawa, Yousuke (1); Kitagawa, Hiroaki (1); Fujiwara, Naozumi (2); Otsuji, Masayuki (2); Takahashi, Hiroaki (2); Fukami, Kazuhiro (3)  
1: SCREEN Holdings Co., Ltd., Japan;

### 08:20 – 08:40

**6.2 - Formulation and Evaluation of Diluted Sulfuric-Peroxide-HF (DSP+) Mixtures for Cleaning High-Aspect Ratio Contacts in 3D NAND (student presentation)**  
An, Kook-Hyun; Kim, Hyun-Tae; Kim, Tae-Gon; Park, Jin-Goo  
Hanyang University, Korea, Republic of (South Korea)

### 08:40 – 09:00

**6.3 - PDMS Micro-Channels Application for the Study of Dynamic Wetting of Nanoetched Silicon Surfaces Based on Acoustic Characterization Method (student presentation)**  
Salhab, Abbas (1,2); Carlier, Julien (1); Campiston, Pierre (1); Neyens, Marc (2); Toubal, Malik (1); Nongaillard, Bertrand (1); Thomy, Vincent (3)  
1: Univ. Polytechnique Hauts-de-France, CNRS, Univ. Lille, ISEN, Centrale Lille, UMR 8520 - IEMN - Institut d’Électronique de Microélectronique et de Nanotechnologie, DOAE - Département d’Opto-Acousto-Électronique, F-59313 Valenciennes, France; 2: STMicroelectronics, 850 rue Monnet, F-38926 Crolles, France; 3: Institute of Electronics, Microelectronics and Nanotechnology, Univ. Lille, UMR 8520 - IEMN, F-59000 Lille, France

### 09:00 – 09:20

**6.4 - Characterization of Wetting of Deep Silica Nanoholes by Aqueous Solutions Using ATR-FTIR**  
Vereecke, Guy (1); Dochain, Denis (2); De Coster, Hanne (3); Conlan, Shona (4); Nurekeyeva, Kunsulu (3); Nsimba, Anthony (4)  
1: imec, Belgium; 2: UCLouvain, Belgium; 3: KULeuven, Belgium; 4: TU Dublin, Ireland

### 09:20 – 09:40

**6.5 - New Test Structure Development for Pattern Collapse Evaluations**  
Xu, XiuMei  
imec, Belgium

### 09:40 – 10:00

**6.6 - Breakthrough of Sublimation Drying by Liquid Phase Deposition**  
Sasaki, Yuta (1); Hanawa, Yosuke (1); Otsuji, Masayuki (2); Fujiwara, Naozumi (2); Kato, Masahiko (2); Yamaguchi, Yu (2); Takahashi, Hiroaki (2)  
1: SCREEN Holdings Co., Ltd., Japan; 2: SCREEN Semiconductor Solutions Co., Ltd., Japan
SESSION 7 - PARTICLE REMOVAL

10:00 – 12:00

Chair: Tae-Gon Kim HanYang University
Co-Chair: Antoine Pacco imec

10:00 – 10:20
7.1 - Study on Uniform Deposition on 300 mm Silicon Wafer with sub-100 nm Sized Particles for Cleaning Application (student presentation)
Lee, Seungjae (1); Hong, Seokjun (1); Oh, Haerim (3); Chae, Seung-ki (4); Kim, Taesung (1,2)
1: School of Mechanical Engineering, Sungkyunkwan University, Korea; 2: SKKU Advanced Institute of Nanotechnology, Sungkyunkwan University, Korea; 3: Engineering Lab, SEMES, Korea; 4: Research & Business Foundation, Sungkyunkwan University, Korea

10:20 – 10:40
7.2 - Ultrafine Particle Removal in the Wafer Cleaning Process Using High Concentration DIO3-DHF Mixture (student presentation)
Han, Hyeon Joon; Lee, Hunhee; Kim, Charles; Kim, Yongmok
1: SCREEN Holdings Co., Ltd., Japan;

10:40 – 11:00
7.3 - Particle Removal in Ultrasonic Water Flow Cleaning Role of Cavitation Bubbles as Cleaning Agents
Ando, Keita (1); Sugawara, Mao (1); Sakota, Riria (1); Ishibashi, Tomoatsulshibashi (2); Matsuo, Hisanori (2); Watanabe, Katsuhide (2)
1: Keio University, Japan; 2: Ebara Corporation, Japan

11:00 – 11:20
7.4 - Scalable Particle Removal for sub-5 nm Nodes
Yoshida, Yukifumi (1); Akiyama, Katsuya (1); Zhang, Song (1); Ueda, Dai (2); Inaba, Masaki (1); Takahashi, Hiroaki (1)
1: SCREEN Semiconductor Solutions Co., Ltd.; 2: SCREEN Holdings Co., Ltd.

11:20-11:40
7.5 - The Effect of Thermal Aging on Nanoparticle Removal (student presentation)
Kim, Yeoho (1); Jin, Seung-Wan (1); Kim, Hyun-Tae (2); Kim, Tae-Gon (3); Won, Kyu-Hwang (4); Park, Jin-Goo (1,2)
1: Department of Materials Science and Chemical Engineering, Hanyang University, Ansan, 15588, Republic of Korea; 2: Department of Bio-Nano Technology, Hanyang University, Ansan, 15588, Republic of Korea; 3: Department of Smart Convergence Engineering, Hanyang University, Ansan, 15588, Republic of Korea; 4: Samsung Electronics Co., Ltd, Hwaseong, 18448, Republic of Korea

11:40 – 12:00 BREAK
Each poster author is allocated 3 minutes to advertise his/her poster using max 3 slides.

P01 - Simulation of Rayleigh Bubble Growth near a No-Slip Rigid Wall (student presentation)
Tanaka, Tomoya; Ando, Keita
Keio University, Japan

P02 - Interaction between Free-Surface Oscillation and Bubble Translation in a Megasonic Cleaning Bath (WITHDRAWN)
Katano, Yu; Ando, Keita
Keio University, Japan

P03 - Removal of SOC Hard Mask for Patterning of Work Function Metal by Thermally Activated Ozone Gas
S. Iwahata, M. Inaba, F. Sebaai and E. Altamirano Sanchez
Screen Semiconductor Solutions Co Ltd, Japan

P04 - Removal of Post Etch Residue on BEOL Low-K with Nanolift
Y. Akanishi, Q. T. Le and Efrain Altamirano Sanchez
Screen Semiconductor Solutions Co Ltd, Japan

P05 - Selective Ru or Co Etch for 3nm Applications
HSU, Chien-Pin Sherman; Chen, Polly Yi-Ting
Avantor, Taiwan

P06 - Remote Plasma Etching of Backend Semiconductor Materials for Reliable Packaging
Evertsen, Rogier; Beckers, Nicolle; Wang, Shaoying; Van der Stam, Richard
ASM PT, The Netherlands

P07 - Wafer Container Monitoring concerning Airborne Molecular Contaminations along a 300 mm Power Semiconductor Production Flow
Franze, Peter (1); Schneider, Germar (1); Kaskel, Stefan (2)
1: Infineon Technologies Dresden GmbH & Co. KG, Germany; 2: Chair of Inorganic Chemistry I, Technical University of Dresden, Germany

P08 - Si1-XGeX Selective Etchant for Gate-All-Around Transistors
Harada, Ken (1); Suzuki, Tatsunobu (2); Kusano, Tomohiro (1); Takeshita, Kan (1); Oniki, Yusuke (3);
Altamirano-Sánchez, Efrain (3); Struyf, Herbert (3); Holsteyns, Frank (3)
1: Mitsubishi Chemical Corporation, Japan; 2: Mitsubishi Chemical Corporation, Japan; 3: imec, Belgium

P09 - Challenges and Solutions of Replacement Metal Gate Patterning to Enable Gate-All-Around Device Scaling
Oniki, Yusuke (1); Ragnarsson, Lars-Ake (1); lino, Hideaki (2); Cott, Daire (1); Chan, Boon Teik (1); Sebaai, Farid (1);
Hopf, Toby (1); Dekkers, Harold (1); Dentoni Litta, Eugenio (1); Altamirano-Sánchez, Efrain (1); Holsteyns, Frank (1);
Horiguchi, Naoto (1)
1: imec, Belgium; 2: Kurita, Japan
SESSION 8 - FUNDAMENTALS OF MEGASONIC AGITATION 14:20 – 15:20

Chair: Ara Philipossian  
University of Arizona, Tucson

Co-Chair: Martin Knottet  
NXP Semiconductors

14:20 – 14:40
8.1 - Visualization of Acoustic Waves and Cavitation in Ultrasonic Water Flow
Usui, Hidehisa (1); Ishibashi, Tomoatsu (2); Matsuo, Hisanori (2); Watanabe, Katsuhide (2); Ando, Keita (1)
1: Keio University, Japan; 2: Ebara Corporation, Japan

14:40 – 15:00
8.2 - Effect of Surfactant in Gas Dissolved Cleaning Solutions on Acoustic Bubble Dynamics
Han, SoYoung (1); Yeriboina, Nagendra Prasad (1); Kim, Dong Gyu (1); Sahoo, Bichitra Nanda (1); Kang, Bong Kyeun (3); Klipp, Andreas (4); Lim, Geon Ja (3); Kim, Tae Gon (2); Park, Jin Goo (1)
1: Department of Materials Science and Chemical Engineering, Hanyang University, Ansan, 15588, Republic of Korea; 2: Department of Smart Convergence Engineering, Hanyang University ERICA, Ansan 15588, Republic of Korea; 3: BASF Company Ltd., Suwon 16419, Republic of Korea; 4: BASF SE, Ludwigshafen, 67056, Germany

15:00 – 15:20
8.3 - Estimation of the Generation Rate of h⁺ Radicals in a Megasonic Field Using an Electrochemical Technique
Han, Zhenxing (2); Raghavan, Srin (1); Beck, Mark (3)
Thursday 15 April 2021

SESSION 9 - BEOL: INTERCONNECTS AND PACKAGING 10:50 – 12:50

Chair: Andreas Klipp    BASF
Co-Chair: Gyuhyung Kim    SK HYNIX

10:30 – 10:50  9.1 - Copper Catalysis Effect Investigation for TiW Etch Process on Patterned Wafers
Venegoni, Ivan; Votta, Annamaria; Bellandi, Enrico; Pipia, Francesco; Alessandri, Mauro
STMicroelectronics, Italy

10:50 – 11:10  9.2 - Selective nickel platinum removal without titanium nitride metal gate corrosion
Garnier Philippe, Audoin, Marine (1); Pizzetti, Christian (1); Loup, Virginie (2); Gabette, Laurence (2); Morote, Carlos (3); Dekraker, David (3); Schwab, Brent (3)
1: Technic, France; 2: CEA - Leti, France; 3: TEL Manufacturing and Engineering of America, USA

11:10 – 11:30  9.3 - Roughness and uniformity control during wet etching of molybdenum
Pacco, Antoine (1); Akanishi, Yuya (2); Le, QuocToan (1)
1: imec, Belgium; 2: SCREEN, Semiconductor Solutions.

11:30 – 11:50  9.4 - Effect of Surface Chemistry on Ruthenium Wet Etching
LE, Quoc Toan; KESTERS, Els; DOMS, Mathias; ALTAMIRANO SANCHEZ, Efrain
imec, Belgium

11:50 – 12:10  BREAK

SESSION 10 - POST-CMP CLEANING 12:10 – 15:10

Chair: Lieve Teugels    imec
Co-Chair: Francesco Pipia    STM

Kim, Juhwan (1); Hong, Seokjun (1); Bae, Chulwoo (2); Wada, Yutaka (3); Hiyama, Hirokuni (3); Hamada, Satomi (3); Kim, Taesung (1,2)
1: Department of Mechanical Engineering, Sungkyunkwan University, Korea, Republic of (South Korea); 2: Department of SKKU Advanced Institute of Nano Technology, Sungkyunkwan University, Korea, Republic of (South Korea); 3: Ebara Corp (Japan)

12:30 – 12:50  10.2 - Nodule Deformation of PVA Roller Brushes on a Rotating Plate: Optimum Cleaning for Nanosized Particles due to Liquid Absorption and Desorption of Sponge Deformation
Miyaki, Tsubasa (1); Mizushima, Yuki (1); Hamada, Satomi (2); Koshino, Ryota (2);
Fukunaga, Akira (2); Sanada, Toshiyuki (1)
1: Shizuoka University, Japan; 2: Ebara Corporation, Japan
12:50 – 13:10

10.3 – Mechanism of PVA Brush Loading with Ceria Particles during Post-CMP Cleaning Process (student presentation)

Sahir, Samrina (1); Cho, Hwi-Won (1); Yerriboina, Nagendra Prasad (1); Kim, Tae-Gon (2); Wada, Yutaka (3); Hamada, Satomi (3); Hiyama, Hirokuni (3); Park, Jin-Goo (1)

1: Department of Materials Science and Chemical Engineering, Hanyang University, Ansan, Korea; 2: Department of Smart Convergence Engineering, Hanyang University, Ansan, Republic of Korea, 15588.; 3: EBARA Corporation, Fujisawa, Kanagawa, Japan

13:10 – 13:30

10.4 – Effect of Dissolved Oxygen on Removal of Benzotriazole from Co during a Post-Co CMP Cleaning (student presentation)

Ryu, Heon-Yul (1); Sahoo, Bichitra Nanda (1); Yerriboina, Nagendra Prasad (1); Kim, Tae-Gon (1); Hamada, Satomi (2); Park, Jin-Goo (1)

1: Hanyang University, Korea, Republic of (South Korea); 2: EBARA Corporation, Japan

13:30 – 14:30 BREAK (PC MEETING)

14:30 – 14:50

10.5 – Tribological Characterization of Anionic Supramolecular Assemblies in Post-STI-CMP Cleaning Solution Using a Novel Post-CMP PVA Brush Scrubber

Philipossian, Ara (1); Sampurno, Yasa (1); Theng, Sian (1); Sudarho, Fransisca (1); Wortman-Otto, Katherine (2); Graverson, Carolyn (2); Keleher, Jason (2)

1: Araca, Inc., USA; 2: Lewis University, USA

14:50 – 15:10

10.6 – Contact vs. Non-Contact Cleaning: Correlating interfacial reaction mechanisms to processing methodologies for enhanced FEOL/BEOL post-CMP cleaning (invited speaker)

Katherine M. Wortman-Otto, Abigail N. Linhart, Allie M. Mikos, Kiana A. Cahue, and Jason J. Keleher

Lewis University, Department of Chemistry, Romeoville IL

SESSION 11 - CLOSURE

15:20 – 16:00

Concluding remarks & best student papers: awards

P. Mertens & K. Wostyn