

SEMATECH

18th Advanced Equipment  
Control/Advanced Process Control  
Symposium  
2006

AEC/APC Symposium XVIII

September 30 – October 4, 2006  
Westminster, Colorado, USA

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571  
[www.proceedings.com](http://www.proceedings.com)

ISBN: 978-1-60560-717-7

**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright (2006) by SEMATECH.

All rights reserved.

For permission requests, please contact SEMATECH at the address below.

SEMATECH  
2706 Montopolis Drive  
Austin, Texas 78741-6499  
Phone: 512-356-3500  
Fax: 512-356-7848

[Web.info@E-sematech.org](mailto:Web.info@E-sematech.org)

# TABLE OF CONTENTS

<b>Advanced Process Control using Equipment Engineering System (EES) Approach.....</b>	<b>1</b>
<i>Kevin Nguyen, Chin Sun</i>	
<b>A Novel 'Z' Based Tool Controller for Lithography APC Applications .....</b>	<b>3</b>
<i>Gene Smith</i>	
<b>A Model-based Performance Monitoring Method for EWMA Controllers.....</b>	<b>5</b>
<i>Amogh V Prabhu, Robert J Chong, Thomas F Edgar</i>	
<b>Method for Real Time Monitoring of Gas Composition with High Sensitivity Using Optical Emission Spectroscopy.....</b>	<b>7</b>
<i>K.C. Harvey, Yongjin Kim</i>	
<b>An Algorithm for the Initialization of Thread States: Thread Reconstruction .....</b>	<b>8</b>
<i>Richard Good, Uwe Schulze</i>	
<b>An MILP Approach to Wafer Sampling and Selection .....</b>	<b>10</b>
<i>Richard Good, Matthew Purdy</i>	
<b>RedEye Integrated Thin Film Metrology and Its Applications in Process Control .....</b>	<b>12</b>
<i>Mei-Wei Tsao, Gary Marshall, Jonathan Barrington</i>	
<b>Computing Requirements for Successful DFM Strategies in the Sub-Wavelength Lithography Era.....</b>	<b>16</b>
<i>Matthew Sexton</i>	
<b>A Novel Approach to Provide a Recipe Management System (RMS) .....</b>	<b>17</b>
<i>Kevin Nguyen, Tuan Le, Lan Do</i>	
<b>Challenges Facing Industry Adoption of Interface A .....</b>	<b>19</b>
<i>Michael Arnold, Thomas Marsh, Eberhard Teichmann</i>	
<b>Automatic Message Classification .....</b>	<b>20</b>
<i>Arthur Griesser</i>	
<b>Flexible Golden Pattern (FGP) - A Statistical Approach of Abnormality Detection and Its Applications .....</b>	<b>21</b>
<i>Jérôme Lacaille, Maxime Zagrebnev</i>	
<b>Wafer-to-wafer Virtual Metrology Applied to Gate Critical Dimension Run-to-Run Control in High Volume Manufacturing.....</b>	<b>23</b>
<i>Jérôme Besnard, Anthony Toprac</i>	
<b>Enhancement of Multiple Model Handling Capability of an APC System on Demand of Switchable CMP Tool Status.....</b>	<b>25</b>
<i>Kyung-cheol Kim, In-sik Chin, Seung-man Lee, William Choi</i>	
<b>Auto Pattern Recognition Fault Detection System Design for Diagnosing Semiconductor Tool and Process Variations.....</b>	<b>28</b>
<i>Hung-Wen Chiou, Tings Wang</i>	
<b>P2P Control of Cu Seed Sputtering Process under Manufacturing Condition with Severe Product Mixing.....</b>	<b>30</b>
<i>Yonghee Lee, Jinho Hwang, Kwangjae Lee, Insik Chin, William Choi, Dongjin Cha</i>	
<b>Tunable Tool Performance – Getting More from the Same Tool .....</b>	<b>33</b>
<i>Boaz Brill, Tal Marcu, Igor Turovets, Ronen Urenski, Elad Dotan, Lee Barnea</i>	
<b>On Run-to-Run State Estimation in Low-volume High-mix Semiconductor Manufacturing.....</b>	<b>35</b>
<i>Jin Wang</i>	
<b>A Multivariate Fault Detection Method using k-Nearest-Neighbor Rule .....</b>	<b>37</b>
<i>Q. Peter He, Jin Wang</i>	

<b>CD Control for a High Part Count Manufacturing Line Using CD Normalization</b> .....	39
<i>Christopher P. Ausschnitt, David A. Crow, William A. Muth, Keith E. Roberts;</i>	
<b>System of Help for Decision Based on a Statistical Multivariate Approach: Applying to Defected Wafers</b> .....	40
<i>Bouchra Ananou, Abderhmane Boubezoul, Mustapha Ouladsine, Mostafa Eladel, Franck Gasnier, Jacques Pinaton</i>	
<b>Title: Novellus Interface A Experience on Implementation and Deployment</b> .....	42
<i>Janeway Dong</i>	
<b>A Machine Learning Approach for Dry Etch Chamber Characterization and Run-to-Run Loop Study</b> .....	43
<i>Agnès Roussy, Nader Jedidi, Rodrigo Fernandez, Jérôme Kodjabachian, Franck Gasnier, Michel Juge</i>	
<b>An Improved Process for Direct Shallow Trench Isolation (STI) Wet Etch Using Post-CMP Metrology Information</b> .....	45
<i>Agnès Roussy, Djaffar Belharet, Pascal Fornara, Jérôme Cires, Philippe Collot, Jacques Pinaton</i>	
<b>Advanced WAT Monitoring/Prediction System via DMLD Approach</b> .....	46
<i>T.Z. Lin, C.Y. Kuo, Y.Z. Tian, S.H. Gau, C.C. Chen, J.F. Wang</i>	
<b>Approach to Real Time Monitoring of Contact Not Open Issue in Dry Etch Process Using Optical Emission Spectroscopy with Multivariate Analysis</b> .....	48
<i>Yongjin Kim, Changjin Kang, Hanku Cho, Jootae Moon</i>	
<b>Enhancing EWMA Control by a Prediction Model</b> .....	49
<i>Sanghyeok Seo</i>	
<b>To EDA Enable a SECS/GEM based APC System</b> .....	50
<i>Chih Chuan Shih</i>	
<b>Systematic Approach to Minimizing Wafer to Wafer Variations in Plasma Etch Processes</b> .....	52
<i>Kye Hyun Baek, Jae Hyun Lee, Jong Hoon Kang, Young Soo Lim, Yong Jin Kim, Chang Jin Kang, Han Ku Cho, Joo Tae Moon</i>	
<b>Hybrid Data Management for Very Large Real-time Data Processing in Semiconductor Manufacturing</b> .....	53
<i>Eunmi Choi</i>	
<b>Application of SPC Model with Multivariate Analysis in Etch Process</b> .....	55
<i>Zhuo Chen, Rongfu Li, Masao Ito, Jian Ding</i>	
<b>An In Situ Measurement Methodology for Maintenance Prediction with SPC Model</b> .....	56
<i>Zhuo Chen, Rongfu Li, Masao Ito, Jian Ding</i>	
<b>Multivariate FDC For Non-Normal Equipment Parameters</b> .....	57
<i>John Mao</i>	
<b>Comparison Study of Multiple Lithographic CD Run-to-Run Controllers</b> .....	58
<i>John Mao, Wei Kang</i>	
<b>Wafer-less Auto Clean Efficiency Study for Silicon Trench Etch Application</b> .....	59
<i>Hui Chen, Fred Session, Briant Harward</i>	
<b>Guaging Security of Interface A/C Implementations via a Baseline Operational Security Standard</b> .....	61
<i>Cris DeWitt</i>	
<b>Understanding the Many Flavors of MVA for FDC</b> .....	62
<i>Chris Ambrozic</i>	
<b>In Die Thickness Measurements for CMP Process Control</b> .....	63
<i>Yoel Cohen, Igor Turovets, Cornel Bozdog, David Mikolas</i>	
<b>Use of Upstream Chamber Information to Control Wafer-to-Wafer CMP Planarization</b> .....	64
<i>Michael Fenrick, Benno Milmore</i>	

<b>Lithography Equipment Control Using Scatterometry Metrology &amp; Semi-Physical Modeling .....</b>	<b>66</b>
<i>Alok Vaid, Kevin Lensing, Jason Cain, Qiaolin Zhang, Eric Apelgren</i>	
<b>A Real-Time Monitoring and Data Acquisition Package for Ion Implantation Process Control .....</b>	<b>68</b>
<i>Karen McPherson</i>	
<b>Recipe Management and Editing System.....</b>	<b>69</b>
<i>Vrunda Bhagwat</i>	
<b>Virtual Metrology: A Solution for Wafer to Wafer Process Monitoring and Throughput Enhancement .....</b>	<b>71</b>
<i>Frank Y. Wang, Niall Macgearailt, John Mao, Peter Raulefs</i>	
<b>Practical Aspects Impacting Time Synchronization Data Quality in Semiconductor Manufacturing.....</b>	<b>72</b>
<i>James Moyne, Jonathan Parrott, Naveen Kalappa, Ya-Shian Li</i>	
<b>E133: The Process Control Systems (PCS) SEMI Standard: Applying the Standard to Fault Detection Scenarios Incorporating Interface A Data Collection and other PCS Capabilities.....</b>	<b>74</b>
<i>Authors: Hazem Hajj , James Moyne</i>	
<b>When AEC is Not Enough: Advanced CVD Deposition Control in High Volume Production.....</b>	<b>76</b>
<i>Ying Wang, Bob Mohondro</i>	
<b>Real-Time Excursion Control for Manufacturing Effectiveness .....</b>	<b>78</b>
<i>Robert Teaglea, Jennifer M. Braggina, Erez Golanb</i>	
<b>Real-Time In Situ Gas Concentration Metrology System For Process Monitoring and Control .....</b>	<b>80</b>
<i>Ted Moore</i>	
<b>Intel's FDC Proliferation in 300mm HVM: Progress and Lessons Learned .....</b>	<b>81</b>
<i>Ted Moore, Brian Harner, Greg Kestner, Chuck Baab, Jesse Stanchfield</i>	
<b>In-situ Monitoring of Photoresist Thickness Uniformity in Microlithography .....</b>	<b>82</b>
<i>W.K. Ho, X.D. Wu, X.Q. Chen, Arthur Tay</i>	
<b>Financial Study of Fault Detectio Systems' Operation .....</b>	<b>84</b>
<i>Bruce Whitefield</i>	
<b>Advanced Inspection Planning Models to Decrease Defect Inspection Costs and Increase Yield .....</b>	<b>86</b>
<i>Dadi Gudmundsson</i>	
<b>Real-time Monitoring and Control of Photoresist Development Process in Microlithography .....</b>	<b>88</b>
<i>W.K. Ho, X.D. Wu, X.Q. Chen+C91, Arthur Tay</i>	
<b>Recipe and Parameter Management as a Consumer of APC.....</b>	<b>91</b>
<i>Lance Rist</i>	
<b>Recipe Management (RaP) Commercial Prototype Using XML/SOAP and SECS/GEM In Parallel - Lessons Learned .....</b>	<b>93</b>
<i>Bert Mueller, Volker Buschendorf, Lance Rist, Artur Lederhofe</i>	
<b>Developing e-Diagnostic Systems in Recent Semiconductor Equipment and Device Manufacturing Industry .....</b>	<b>95</b>
<i>Kyoung-Shik Jun, Kanth Krishnan, Satish Baskaran, Shannon McGinley</i>	
<b>Defect Warning System for High-End Mask Fabrication .....</b>	<b>98</b>
<i>Min Ah Kim, Kwang Hyuk Im, Sang Yong Yu, Yong Hoon Kim, Sang Gyun Woo, Woosung Han</i>	
<b>Using a Predictive Model to Determine Copper Waste Effluent.....</b>	<b>99</b>
<i>Dan Wilcox, Thomas Scharmann</i>	
<b>Batch PLS Analysis and FDC Process Control of Within Lot SiON Gate Oxide Thickness Variation in Sub-nanometer Range.....</b>	<b>100</b>
<i>Justin Wong, Tamara Adamson, Anthhony Chou, Joseph Shepard, Wei He, Michael Passow</i>	
<b>Strategies for Successfully Implementing Fab-wide FDC Methodologies in Semiconductor Manufacturing.....</b>	<b>101</b>
<i>Justin Wong, Tamara Adamson, Gary Moore, Michael Passow, Viheng Xu</i>	

<b>Heuristic and Statistical Methods for Fault Detection: Complementary or Competing Approaches?</b> .....	102
<i>Jared Warren</i>	
<b>A Comparison of Industry Approaches to Remote Diagnosis and Maintenance</b> .....	103
<i>John Krieger</i>	
<b>Run by Run APC Deployment in 65nm Thin Film Module</b> .....	105
<i>Jerry Stefani, Kilby Fab</i>	
<b>Correlating Process Parameters, Violations and Alarms - An Approach for Deeper Insight in Production Processes</b> .....	107
<i>Almuth Behrisch, Jörn Maeritz</i>	
<b>Beta Test Results for a Yield Optimizer</b> .....	109
<i>William Martin, An Carlson, Jill Card</i>	
<b>Advances in Trace Moisture Analysis in Corrosive and Hydride Gases Using Continuous-wave Cavity Ring-down Spectroscopy</b> .....	110
<i>Yu Chen, Hans Funke, Mark W. Raynor, Kris Bertness</i>	
<b>Polysilicon Gate Etch Process Control in High Volume Manufacturing using Scatterometry-based Integrated Metrology and Wafer-to-Wafer Process Control</b> .....	111
<i>Kenneth A. Bandy, Matthew Sendelbach, Eric M. Meyette, Dan Prager, Merritt Funk</i>	
<b>Utilizing APC and EpT as an Integral Part of Scheduling and Maintenance Optimization</b> .....	113
<i>Kevin Dimond, Tony Mullins, Brad Schulze, Keith Edwards, Mark Yelverton</i>	
<b>Architecture and Implementation of High Speed Data Collection for Copper Electroplating Applications</b> .....	115
<i>Michael Neel, Courtney Fowler-Bolf, Andy Hebda, Russ Bennett, Bala Balakrishnan, Nathan Graff, John Bacon</i>	
<b>Advancing Towards Factory-Wide Data Quality for APC Applications</b> .....	116
<i>Harvey Wohlwend, Ya-Shian Li</i>	
<b>Capability Maturity Model for (CMM) Semiconductor Equipment Engineering Systems (EES)</b> .....	117
<i>Paul McGuire</i>	
<b>Functional Roadmap for Semiconductor Equipment Engineering Systems (EES)</b> .....	118
<i>Paul McGuire, Alan Weber</i>	
<b>Migrating from a Legacy Run-by-Run Control System</b> .....	120
<i>Victor M. Martinez, Laura Pitts, Bala Balakrishnan</i>	
<b>Maximising the Return on Investment of a FDC System</b> .....	121
<i>Paul Heynen, Marcus Carbery</i>	
<b>Migrating to SEMI Standard Networked Safety Systems in Semiconductor Tool: A Case Study</b> .....	122
<i>Richard Gwizdak, Thomas Hoertig</i>	
<b>Automatic e-Diagnosis</b> .....	124
<i>Jun Shien Lin, Kewei Zuo, Shuh-Chwen Yeh, Francis Ko, Henry Lo, Jean Wang, C.H. Yu, Tien Wen Wang, Jong I Mou</i>	
<b>Neural-Network based Virtual Metrology for Semiconductor Industry</b> .....	125
<i>Jonathan Yung</i>	
<b>Engineering CIM Framework for Advanced Technology Deployment</b> .....	126
<i>M.Y. Hung, B.C. Chen, Allan Chen, P.H. Chen</i>	
<b>Excursion Prevention System for Advanced Lithography Scanner Systems</b> .....	127
<i>Eli Ben-Hamu, Iris Green, Yehuda Root</i>	
<b>Automatic EP Configuration and Tailored Excursion Prevention Solutions</b> .....	129
<i>Oren Cohen</i>	

<b>Ultimate Control: Manage Quality Through Charts (MQTC)</b> .....	130
<i>Minsky Avi, Dar Noga, Arbel Roni, Baumer Michal</i>	
<b>Gate CD Control for the 65 nm Technology Node</b> .....	132
<i>John Stuber, Vladimir Ukraintsev, Craig Hall, Gary Zhang, Jim Friedman</i>	
<b>Selecting the Best Sensor - A Challenge for Developing AEC</b> .....	134
<i>David Dolan</i>	
<b>Strategy for implementing <i>Intelligent</i> APC in Semiconductor Manufacturing</b> .....	136
<i>Michael Passow</i>	
<b>AIPC - Putting the <i>Intelligence</i> in APC</b> .....	138
<i>Perry Hartswick</i>	
<b>Providing APC and Integrated Metrology Input to the International Technology Roadmap for Semiconductors (ITRS)</b> .....	140
<i>James Moyne, Brad Van Eck</i>	
<b>Challenges and Opportunities in Advanced Process Control for Nanometer Era Technologies</b> .....	142
<i>Andrzej Strojwas</i>	
<b>Novel Method for Performance Assessment of Run-to-run EWMA Performers</b> .....	188
<i>Amogh V. Prabhu, Thomas F. Edgar</i>	
<b>Across Wafer Post Etch CD Uniformity Enhancement through Model Based Control</b> .....	192
<i>Qiaolin Zhang, Kameshwar Poola, Costas Spanos</i>	
<b>Strong Tracking Filter for Control of Run-to-Run Semiconductor Fabrication</b> .....	197
<i>Daniel Brad, Donghua Zhou, S.J. Qin</i>	

## **Author Index**