

# **2016 IEEE International Interconnect Technology Conference/Advanced Metallization Conference (IITC/AMC 2016)**

**San Jose, California, USA  
23 – 26 May 2016**



**IEEE Catalog Number: CFP16ITR-POD  
ISBN: 978-1-5090-0387-7**

**Copyright © 2016 by the Institute of Electrical and Electronics Engineers, Inc  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\*This publication is a representation of what appears in the IEEE Digital Libraries. Some format issues inherent in the e-media version may also appear in this print version.***

|                         |                   |
|-------------------------|-------------------|
| IEEE Catalog Number:    | CFP16ITR-POD      |
| ISBN (Print-On-Demand): | 978-1-5090-0387-7 |
| ISBN (Online):          | 978-1-5090-0386-0 |
| ISSN:                   | 2380-632X         |

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

## TABLE OF CONTENTS

|  |           |
|--|-----------|
| <b>KEYNOTE PRESENTATION: SEMI CONSOLIDATION IN AN AGE OF MOORE ANXIETY .....</b>   | <b>1</b>  |
| <i>Joe Sawicki</i>   |           |
| <b>BEOL PROCESS INTEGRATION FOR THE 7 NM TECHNOLOGY NODE .....</b>   | <b>2</b>  |
| <i>T. Standaert ; G. Beique ; H. -C. Chen ; S. -T. Chen ; B. Hamieh ; J. Lee ; P. McLaughlin ; J. McMahon ; Y. Mignot ; F. Mont ; K. Motoyama ; S. Nguyen ; R. Patlolla ; B. Peethala ; D. Priyadarshini ; M. Rizzolo ; N. Saulnier ; H. Shobha ; S. Siddiqui ; T. Spooner ; H. Tang ; O. van der Straten ; E. Verduijn ; Y. Xu ; X. Zhang ; J. Arnold ; D. Canaperi ; M. Colburn ; D. Edelstein ; V. Paruchuri ; G. Bonilla</i>   |           |
| <b>PERFORMANCE ENHANCEMENT FOR 14NM HIGH VOLUME MANUFACTURING MICROPROCESSOR AND SYSTEM ON A CHIP PROCESSES .....</b>  | <b>5</b>  |
| <i>K. Fischer ; H. K Chang ; D. Ingerly ; I. Jin ; H. Kilambi ; J. Longun ; R. Patel ; C. Peltz ; C. Petersburg ; P. Plekhanov ; C. Puls ; L. Rockford ; I. Tsameret ; M. Uncuer ; P. Yashar</i>   |           |
| <b>450MM CU SINGLE DAMASCENE BEOL PROCESS WITH 20NM HALF-PITCHED FEATURES .....</b>  | <b>8</b>  |
| <i>Sunoo Kim ; Shannon Dunn ; Steven Smith ; WenLi Collision ; Jamie Prudhomme ; Huey-Ming Wang ; Joe Maniscalco ; Nithin Yathapu ; Chulgi Song ; Barry Wang ; Christopher Carr ; Hsi-Wen Liu ; Bruce Gall ; Angelo Alaestante ; Min-Hui Chen ; Richard Conti ; ChungJu Yang ; Denis Sullivan ; Kosta Culafic ; BumKi Moon ; Yili-Cheng Lin ; Yu-Lieh Fu ; Katherine Sieg ; Anne-Sophie Larrea ; Norman Fish ; Regina Swaine ; Alexander Bialy ; Milo Tallon ; Gerard Stapf ; John Hagwood ; Michael Bryant ; Rand Cottle ; Stock Chang ; Mark Kelling ; Karsten Schaefer ; Dan Franca ; Pinyen Lin ; Christopher Borst ; Kwangwook Lee ; JongHeun Lim ; David Skilbred ; C. Chien ; Frank Robertson ; Erin Fria</i> |           |
| <b>TECHNOLOGY AND DESIGN ARCHITECTURES AND PROCESS INNOVATIONS FOR 7 AND 5NM BEOL INTERCONNECTS .....</b>  | <b>11</b> |
| <i>Larry Clevenger</i>   |           |
| <b>INTERCONNECT PERFORMANCE AND SCALING STRATEGY AT THE 5 NM NODE .....</b>  | <b>12</b> |
| <i>James Hsueh-Chung Chen ; Nicholas LiCausi ; E. Todd Ryan ; Theodorus E Standaert ; Griselda Bonilla</i>   |           |
| <b>10NM LOCAL INTERCONNECT CHALLENGE WITH ISO-DENSE LOADING AND IMPROVEMENT WITH ALD SPACER PROCESS .....</b>  | <b>15</b> |
| <i>Ming He ; Christopher Ordonio ; Chun Hui Low ; Peter Welti ; Granger Lobb ; Aleksandra Clancy ; Jeff Shu ; Ayman Hamouda ; Jason Stephens ; Ketan Shah ; Ashwini Chandrasekhar ; Mary Claire Silvestre ; Prakash Periasamy ; Anbu Selvam KM Mahalingam ; Shyam Pal ; Craig Child</i>  |           |
| <b>ORDERED POROSITY FOR INTERCONNECT APPLICATIONS .....</b>  | <b>18</b> |
| <i>Jessica M. Torres ; Jeff Bielefeld ; James Blackwell ; David J. Michalak ; James S. Clarke</i>  |           |
| <b>TOWARD SUCCESSFUL INTEGRATION OF GAP-FILLING ULTRALOW-K DIELECTRICS .....</b>   | <b>21</b> |
| <i>L. Zhang ; J. -F. de Marneffe ; A. Leśniewska ; P. Verdonck ; N. Heylen ; G. Murdoch ; K. Croes ; Zs. Tökei ; J. Bömmels ; S. Lefferts ; S. De Gendt ; M. R. Baklanov</i>   |           |
| <b>PHYSICAL VAPOR DEPOSITED ALN AS SCALABLE AND RELIABLE INTERCONNECT ETCH-STOP ≤ 10NM NODE .....</b>  | <b>24</b> |
| <i>He Ren ; Yana Cheng ; Yong Cao ; Srinivas Guggilla ; Sree Kesapragada ; Weifeng Ye ; Mehul Naik</i>   |           |
| <b>FABRICATION OF (111) NANOTWINNED CU AND ITS APPLICATIONS IN INTERCONNECTS OF MICROELECTRONIC DEVICES .....</b>  | <b>27</b> |
| <i>Chih Chen ; Chien-Min Liu ; Tien-Lin Lu ; Han-wen Lin ; Yi-Cheng Chu ; Chia-Ling Lu ; Jing-Ye Juang ; Kuan-Neng Chen ; K. N. Tu</i>   |           |
| <b>BARRIER/LINER STACKS FOR SCALING THE CU INTERCONNECT METALLIZATION .....</b>  | <b>28</b> |
| <i>Marleen H. van der Veen ; N. Jourdan ; V. Vega Gonzalez ; C. J. Wilson ; N. Heylen ; O. Varela Pedreira ; H. Struyf ; K. Croes ; J. Bömmels ; Zs. Tökei</i>   |           |
| <b>RUTHENIUM INTERCONNECT RESISTIVITY AND RELIABILITY AT 48 NM PITCH .....</b>   | <b>31</b> |
| <i>Xunyuan Zhang ; Huai Huang ; Raghuveer Patlolla ; Wei Wang ; Frank W. Mont ; Juntao Li ; Chao-Kun Hu ; Eric G. Liniger ; Paul S. McLaughlin ; Cathy Labelle ; E. Todd Ryan ; Donald Canaperi ; Terry Spooner ; Griselda Bonilla ; Daniel Edelstein</i>  |           |
| <b>RUTHENIUM METALLIZATION FOR ADVANCED INTERCONNECTS .....</b>  | <b>34</b> |
| <i>Liang Gong Wen ; Christoph Adelmann ; Olalla Varela Pedreira ; Shibesh Dutta ; Mihaela Popovici ; Basoene Briggs ; Nancy Heylen ; Kris Vanstreels ; Christopher J. Wilson ; Sven Van Elshocht ; Kristof Croes ; Jürgen Bömmels ; Zsolt Tökei</i>  |           |
| <b>CVD-MN/CVD-RU-BASED BARRIER/LINER SOLUTION FOR ADVANCED BEOL CU/LOW-K INTERCONNECTS .....</b>   | <b>37</b> |
| <i>N. Jourdan ; M. H. van der Veen ; V. Vega Gonzalez ; K. Croes ; A. Lesniewska ; O. Varela Pedreira ; S. Van Elshocht ; J. Bömmels ; Zs. Tökei</i>   |           |

|  |    |
|--|----|
| <b>EXPERIMENTAL STUDY OF NANOSCALE CO DAMASCENE BEOL INTERCONNECT STRUCTURES .....</b>   | 40 |
| <i>J. Kelly ; J. H. -C. Chen ; H. Huang ; C. K. Hu ; E. Liniger ; R. Patlolla ; B. Peethala ; P. Adusumilli ; H. Shobha ; T. Nogami ; T. Spooner ; E. Huang ; D. Edelstein ; D. Canaperi ; V. Kamineni ; F. Mont ; S. Siddiqui</i> |    |
| <b>QUANTUM COMPUTING WITH SUPERCONDUCTING CIRCUITS .....</b>   | 43 |
| <i>Robert Schoelkopf</i>   |    |
| <b>MODELING OF GRAPHENE FOR INTERCONNECT APPLICATIONS .....</b>  | 45 |
| <i>A. Contino ; I. Ciofi ; M. Politou ; D. Verkest ; D. Mocuta ; B. Sorée ; G. Groeseneken</i>   |    |
| <b>NANOCARBON INTERCONNECTS COMBINING VERTICAL CNT INTERCONNECTS AND HORIZONTAL GRAPHENE LINES .....</b>   | 48 |
| <i>R. Ramos ; A. Fournier ; M. Fayolle ; J. Dijon ; C. P. Murray ; J. McKenna</i>  |    |
| <b>OVERVIEW OF SPIN-BASED MAJORITY GATES AND INTERCONNECT IMPLICATIONS .....</b>   | 51 |
| <i>I. P. Radu ; O. Zografos ; A. Vayssat ; F. Ciubotaru ; M. Manfrini ; P. Raghavan ; S. Sayan ; C. Adelmann ; Zs. Tökei ; A. Thean</i>  |    |
| <b>PERFORMANCE MODELING AND OPTIMIZATION FOR ON-CHIP INTERCONNECTS IN STT-MRAM MEMORY ARRAYS.....</b>  | 53 |
| <i>Javaneh Mohseni ; Chenyun Pan ; Azad Naeemi</i>   |    |
| <b>PERFORMANCE ANALYSES AND BENCHMARKING FOR SPINTRONIC DEVICES AND INTERCONNECTS .....</b>  | 56 |
| <i>Chenyun Pan ; Sou-Chi Chang ; Azad Naeemi</i>   |    |
| <b>INTERCONNECT RELIABILITY CHALLENGES FOR TECHNOLOGY SCALING: A CIRCUIT FOCUS .....</b>   | 59 |
| <i>Anthony S. Oates</i>  |    |
| <b>A NEW MODEL FOR TDDB RELIABILITY OF POROUS LOW-K DIELECTRICS: PERCOLATION DEFECT NUCLEATION AND GROWTH.....</b>   | 60 |
| <i>Shou-Chung Lee ; A. S. Oates</i>  |    |
| <b>RESISTANCE AND ELECTROMIGRATION PERFORMANCE OF 6 NM WIRES .....</b>   | 63 |
| <i>J. S. Chawla ; S. H. Sung ; S. A. Bojarski ; C. T. Carver ; M. Chandhok ; R. V. Chebiam ; J. S. Clarke ; M. Harmes ; C. J. Jezewski ; M. J. Koprinski ; B. J. Krist ; M. Mayeh ; R. Turkot ; H. J. Yoo</i>                      |    |
| <b>PROCESS OPTIONS TO ENABLE (SUB-)1E-9 OHM.CM<sup>2</sup> CONTACT RESISTIVITY ON SI DEVICES .....</b>   | 66 |
| <i>H. Yu ; M. Schaekers ; S. Demuyrck ; E. Rosseel ; J. Everaert ; S. A. Chew ; A. Peter ; S. Kubicek ; K. Barla ; A. Mocuta ; N. Horiguchi ; N. Collaert ; A. Thean ; K. De Meyer</i>   |    |
| <b>TOWARDS CONTACT INTEGRATION FOR III-V/SILICON HETEROGENEOUS PHOTONICS DEVICES .....</b>   | 69 |
| <i>E. Ghegin ; Ph. Rodriguez ; F. Nemouchi ; C. Jany ; M. Brihoum ; A. Halimaoui ; I. Sagnes ; B. Szelag</i>   |    |
| <b>CONTACTS FOR MONOLITHIC 3D ARCHITECTURE: STUDY OF NI<sub>0.9</sub>CO<sub>0.1</sub> SILICIDE FORMATION.....</b>  | 72 |
| <i>Ph. Rodriguez ; S. Favier ; F. Nemouchi ; C. Sézé ; F. Deprat ; C. Fenouillet-Beranger ; P. Gergaud</i>   |    |
| <b>ON THE ELECTRICAL PERFORMANCE OF RIGID SILICON INTERPOSER.....</b>  | 75 |
| <i>Farhang Yazdani</i>   |    |
| <b>INTERCONNECT ROLES FOR EMERGING MEMORY TECHNOLOGIES IN 3D ARCHITECTURE.....</b>   | 76 |
| <i>Er-Xuan Ping</i>  |    |
| <b>NONDESTRUCTIVE INSPECTION AND INLINE ESTIMATION OF PROFILES OF COPPER-FILLED THROUGH-SILICON VIAS WITH VOIDS BY A NANO-FOCUS X-RAY MICROSCOPE .....</b>   | 77 |
| <i>Yasutoshi Umehara ; Nobuyuki Moronuki</i>   |    |
| <b>EFFECT OF SCALING COPPER THROUGH-SILICON VIAS ON STRESS AND RELIABILITY FOR 3D INTERCONNECTS .....</b>  | 80 |
| <i>Laura Spinella ; Miseok Park ; Jang-hi Im ; Paul Ho ; Nobumichi Tamura ; Tengfei Jiang</i>  |    |
| <b>NUMERICAL AND EXPERIMENTAL EXPLORATION OF THERMAL ISOLATION IN 3D SYSTEMS USING AIR GAP AND MECHANICALLY FLEXIBLE INTERCONNECTS .....</b>   | 83 |
| <i>Yang Zhang ; Thomas. E. Sarvey ; Yue Zhang ; Muneeb Zia ; Muhannad S. Bakir</i>   |    |
| <b>NOVEL APPROACHES TO DETERMINE THERMOMECHANICAL MATERIALS DATA IN ADVANCED INTERCONNECT STACKS .....</b>   | 86 |
| <i>Ehrenfried Zschech ; Martin Gall ; Andre Clausner ; Christoph Sander ; Valeriy Sukharev</i>   |    |
| <b>PRE-LINER DIELECTRIC NITRIDATION FOR RESISTANCE REDUCTION IN COPPER INTERCONNECTS .....</b>   | 89 |
| <i>C. -C. Yang ; T. Spooner ; W. Wang ; J. Maniscalco ; P. McLaughlin ; C. K. Hu ; E. Liniger ; T. Standaert ; D. Canaperi ; R. Quon ; E. Huang ; D. Edelstein</i>   |    |

|   |     |
|---|-----|
| <b>ULTRATHIN CONFORMAL MULTILAYER SINO DIELECTRIC CAP FOR CAPACITANCE REDUCTION IN CU/LOW K INTERCONNECTS .....</b>   | 92  |
| Deepika Priyadarshini ; S. Nguyen ; H. Shobha ; S. Cohen ; T. Shaw ; C. Parks ; E. Adams ; J. Burnham ; E. Liniger ; C. K. Hu ; D. Collins ; T. Spooner ; A. Grill ; D. Canaperi ; Vamsi Paruchuri ; D. Edelstein   |     |
| <b>THERMOMECHANICAL ASYMMETRIES IN ULK DIELECTRIC GLASSES .....</b>   | 95  |
| Joseph A. Burg ; Reinhold H. Dauskardt  |     |
| <b>DESIGN-FOR-STRESS FOR CMOS TECHNOLOGIES - THE NEXT FRONTIER .....</b>  | 98  |
| Riko Radojcic   |     |
| <b>ELECTRICAL PROPERTIES AND TDDB PERFORMANCE OF CU INTERCONNECTS USING ALD TA(AL)N BARRIER AND RU LINER FOR 7NM NODE AND BEYOND .....</b>  | 99  |
| Yuki Kikuchi ; Hiroaki Kawasaki ; Hiroyuki Nagai ; Kai-Hung Yu ; Manabu Oie ; Steve Consiglio ; Cory Wajda ; Kaoru Maekawa ; Gert Leusink   |     |
| <b>MATERIALS SCIENCE OF RU AND RU ALLOY THIN FILMS FOR BARRIER APPLICATIONS .....</b>   | 102 |
| Wen Liao ; Daniel Bost ; Chia-Yun Chiu ; Gyeong S. Hwang ; John G. Ekerdt   |     |
| <b>TUNGSTEN AND COBALT METALLIZATION: A MATERIAL STUDY FOR MOL LOCAL INTERCONNECTS .....</b>  | 105 |
| V. Kamineni ; M. Raymond ; S. Siddiqui ; F. Mont ; S. Tsai ; C. Niu ; A. Labonte ; C. Labelle ; S. Fan ; B. Peethala ; P. Adusumilli ; R. Patlolla ; D. Priyadarshini ; Y. Mignot ; A. Carr ; S. Pancharatnam ; J. Shearer ; C. Surisetty ; J. Arnold ; D. Canaperi ; B. Haran ; H. Jagannathan ; F. Chafik ; B. L'Herron |     |
| <b>FLUORINE-FREE TUNGSTEN FILMS AS LOW RESISTANCE LINERS FOR TUNGSTEN FILL APPLICATIONS .....</b>   | 108 |
| Jonathan Bakke ; Yu Lei ; Yi Xu ; Kazuya Daito ; Xinyu Fu ; Guoqiang Jian ; Kai Wu ; Raymond Hung ; Rajkumar Jakkaraju ; Nicolas Breil  |     |
| <b>DEVELOPMENT OF ELECTROLESS CO VIA-PREFILL TO ENABLE ADVANCED BEOL METALLIZATION AND VIA RESISTANCE REDUCTION.....</b>  | 111 |
| Yu Jiang ; Praveen Nalla ; Yana Matsushita ; Greg Harm ; Jingyan Wang ; Artur Kolics ; Larry Zhao ; Tom Mountsier ; Paul Besser ; Hui-Jung Wu   |     |
| <b>IS ELECTRON TRANSPORT IN NANOCRYSTALLINE CU INTERCONNECTS SURFACE DOMINATED OR GRAIN BOUNDARY DOMINATED? .....</b>   | 114 |
| Ganesh Hegde ; R. Chris Bowen ; Mark S. Rodder  |     |
| <b>TOWARDS THE REALIZATION OF OPTICAL INTERCONNETS ON SI INTERPOSER.....</b>  | 117 |
| S. Killge ; S. Charania ; K. Richter ; J. W. Bartha   |     |
| <b>3D DIE LEVEL PACKAGING FOR HYBRID SYSTEMS.....</b>   | 120 |
| N. P. Vamsi Krishna ; Prosenjit Sen   |     |
| <b>PHOTODETECTOR OF ZNO NANOWIRES BASED ON THROUGH-SILICON VIA APPROACH .....</b>   | 123 |
| Yi-Hao Chen ; I-Tzu Huang ; Shou-Jinn Chang ; Ting-Jen Hsueh  |     |
| <b>NOVEL TOP-DOWN CU FILLING OF THROUGH SILICON VIA (TSV) IN 3-D INTEGRATION .....</b>  | 125 |
| Ting-Chia Weng ; Jun-Liang Lu ; Shou-Jinn Chang ; Ting-Jen Hsueh  |     |
| <b>THERMO-MECHANICAL BEHAVIOR OF COPPER TSV AND THE EFFECT OF ALTERNATIVE METAL LINERS.....</b>   | 127 |
| Jae Shin ; Matthew Thorum ; Joe Richardson  |     |
| <b>IMPACT OF ACROSS-WAFER VARIATION ON THE ELECTRICAL PERFORMANCE OF TSVS .....</b>   | 130 |
| L. Filipovic ; S. Selberherr ; A. P. Singulani ; F. Roger ; S. Carnielo   |     |
| <b>FIRST INTEGRATION OF NI<sub>0.9</sub>CO<sub>0.1</sub> ON PMOS TRANSISTORS .....</b>  | 133 |
| F. Deprat ; F. Nemouchi ; C. Fenouillet-Beranger ; M. Cassé ; Ph. Rodriguez ; B. Previtali ; N. Rambal ; V. Delaye ; M. Haond ; M. Mellier ; M. Gregoire ; M. Danielou ; S. Favier ; P. Batude ; M. Vinet   |     |
| <b>FORMATION AND STABILITY OF INTERMETALLICS FORMED BY SOLID-STATE REACTION OF NI ON IN<sub>0.53</sub>GA<sub>0.47</sub>AS .....</b>   | 136 |
| Seifeddine Zhiou ; Philippe Rodriguez ; Fabrice Nemouchi ; Patrice Gergaud ; Tra Nguyen-Thanh ; Lætitia Rapenne   |     |
| <b>FORMATION AND MICROSTRUCTURE OF THIN Ti SILICIDE FILMS FOR ADVANCED TECHNOLOGIES.....</b>  | 139 |
| P. Adusumilli ; A. V. Carr ; A. S. Ozcan ; C. Lavoie ; J. Jordan-Sweet ; D. Prater ; N. Breil ; S. Polvino ; M. Raymond ; D. Deniz ; V. Kamineni  |     |
| <b>A NOVEL ANALYTICAL CAPACITANCE MODEL FOR SUB-10 NM INTERCONNECTS .....</b>   | 141 |
| Indira Seshadri ; Huai Huang ; Pranita Kerber ; James Chen ; Larry Clevenger  |     |
| <b>GEOMETRY IMPACT ON THE REDUCTION OF CU INTERCONNECT WIRE RESISTANCE: A PERSPECTIVE OF DATA MINING .....</b>  | 144 |
| Wei Wang ; Terry Spooner ; Chih-Chao Yang , XunYuan Zhang   |     |
| <b>THE CU EXPOSURE EFFECT IN AIO ETCH AT ADVANCED CMOS TECHNOLOGIES.....</b>  | 147 |
| Junqing Zhou ; Qiyang He ; Minda Hu ; Kefang Yuan ; Yibin Cao ; Linlin Sun ; Xinghua Song ; Haiyang Zhang   |     |

|  |     |
|--|-----|
| <b>TRANSFORMING THE P4 PROCESS TO ENHANCE MECHANICAL AND FRACTURE PROPERTIES OF ULKS .....</b>   | 150 |
| Scott G. Isaacson ; Can Wang ; Krystelle Lioni ; Willi Volksen ; Teddie P. Magbitang ; Reinhold H. Dauskardt ; Geraud Dubois   |     |
| <b>POST POROSITY PLASMA PROTECTION INTEGRATION AT 48 NM PITCH.....</b>   | 153 |
| Huai Huang ; Krystelle Lioni ; Willi Volksen ; Terry Spooner ; Hosadurga Shobha ; Joe Lee ; James Hsueh-Chung Chen ; Teddie Magbitang ; Brown Peethala ; Eric G Liniger ; Chao Kun Hu ; Elbert Huang ; Donald F Canaperi ; Theodorus E Standaert ; Daniel C. Edelstein ; Alfred Grill ; Geraud Dubois ; Griselda Bonilla |     |
| <b>LASER ANNEAL OF OXYCARBOSILANE LOW-K FILM.....</b>  | 156 |
| M. Redzheb ; S. Armini ; K. Vanstreels ; J. Meersschaut ; M. R. Baklanov ; Y. Wang ; S. Chen ; V. Le ; M. Awdshiew ; P. Van Der Voort  |     |
| <b>REDUCED DAMAGE FOR BEOL INTEGRATION OF ULTRA LOW-K (ULK) DIELECTRIC MATERIALS .....</b>   | 159 |
| Andy Wills ; Meisam Movassat ; Hash Pakbaz ; Nigel Hacker  |     |
| <b>AMORPHOUS CO-TI ALLOY AS A SINGLE LAYER BARRIER FOR CO LOCAL INTERCONNECT STRUCTURE .....</b>   | 162 |
| Maryamsadat Hosseini ; Junichi Koike ; Yuji Sutou ; Larry Zhao ; Steven Lai ; Reza Arghavani   |     |
| <b>THE OXYGEN BARRIER PROPERTIES OF CO<sub>x</sub>MO<sub>y</sub> DIFFUSION BARRIER FOR CU INTERCONNECT.....</b>  | 165 |
| Li-Ao Cao ; Xin-Ping Qu  |     |
| <b>A STUDY ON THE PLATING AND WETTING ABILITY OF RUTHENIUM-TUNGSTEN MULTI-LAYERS FOR ADVANCED CU METALLIZATION.....</b>  | 168 |
| Tai-Chen Kuo ; Yin-Hsien Su ; Wen-Hsi Lee ; Wei-Hsiang Liao ; Yu-Sheng Wang ; Chi-Cheng Hung ; Ying-Lang Wang  |     |
| <b>IMPROVING TUNGSTEN GAP-FILL FOR ADVANCED CONTACT METALLIZATION.....</b>   | 171 |
| Kai Wu ; Sanghyeob Lee ; Vik Banthia ; Raymond Hung  |     |
| <b>LOW-VIA-RESISTANCE AND LOW-COST PVD-TIZRN BARRIER FOR CU/LOW-K INTERCONNECTS .....</b>  | 174 |
| Yu-Chen Chan ; Chao-Hsien Peng ; Ming-Han Lee ; Shin-Yi Yang ; Ching-Fu Yeh ; Shau-Lin Shue  |     |
| <b>VAPOR DEPOSITION OF COPPER-MANGANESE INTERCONNECTS .....</b>  | 177 |
| Roy G. Gordon ; Jun Feng ; Kecheng Li ; Xian Gong  |     |
| <b>CHARACTERIZATION OF ADVANCED SEQUENTIAL FLOW DEPOSITION (ASFD) TION ELECTRODE IN MIM STRUCTURE FOR LEAKAGE CURRENT REDUCTION.....</b>   | 180 |
| Tadahiro Ishizaka ; Masaki Koizumi ; Masaki Sano ; Seokhyoung Hong ; Masato Koizumi ; Cheonsoo Han ; Koji Akiyama ; Sara Aoki ; Kentaro Shiraga ; Tatsuhiko Tanimura   |     |
| <b>A NOVEL BOTTOM UP FILL MECHANISM FOR THE METALLIZATION OF ADVANCED NODE COPPER INTERCONNECTS.....</b>   | 183 |
| V. Mévellec ; M. Thiam ; D. Suhr ; L. Religieux ; P. Blondeau ; J. B. Chaumont ; F. Raynal   |     |
| <b>PROCESS METROLOGY OF COBALT DAMASCENE INTERCONNECTS .....</b>   | 186 |
| Eugene Shalyt ; Michael Palvov ; Xiaodong Yan ; Danni Lin  |     |
| <b>BARRIER LAYER DEPENDENCE OF SELF-ANNEALING EFFECT IN DIRECTLY ELECTROPLATED COPPER FILMS.....</b>   | 189 |
| Xu Wang ; Guang Yang ; Li-Ao Cao ; Xin-Ping Qu   |     |
| <b>DUAL PRECURSOR ATMOSPHERIC PLASMA DEPOSITION OF BILAYER ORGANOSILICATE PROTECTIVE COATINGS ON PLASTICS.....</b>   | 192 |
| Siming Dong ; Zhenlin Zhao ; Reinhold Dauskardt  |     |
| <b>SPRAY DEPOSITION OF COMPOSITIONALLY GRADED HYBRID LAYERS FOR HIGH-PERFORMANCE ADHESION.....</b>   | 195 |
| Yichuan Ding ; Reinhold H. Dauskardt   |     |
| <b>SYNTHESIS OF DOPED CARBON NANOTUBES BY CVD USING NIB CATALYSTS.....</b>   | 198 |
| Kosuke Tomita ; Naoaki Kawakami ; Akihiko Aozasa ; Kou Aida ; Kazuyoshi Ueno   |     |
| <b>MULTI-LAYER GRAPHENE INTERCONNECT: A FEASIBILITY STUDY .....</b>  | 200 |
| Maria Politou ; Xiangyu Wu ; Antonino Contino ; Bart Soree ; Cedric Huyghebaert ; Dennis Lin ; Iuliana Radu ; Zsolt Tokei ; Inge Asselberghs   |     |
| <b>CONTACT RESISTANCE AND RELIABILITY OF 40 NM CARBON NANOTUBE VIAS .....</b>  | 203 |
| Anshul A. Vyas ; Cary Y. Yang ; Phillip Wang ; Changjian Zhou ; Yang Chai  |     |
| <b>AFD-BASED MODEL OF EM LIFETIME AND RESERVOIR EFFECT .....</b>   | 206 |
| Zhong Guan ; Małgorzata Marek-Sadowska   |     |
| <b>INVESTIGATION ON RELIABILITY IMPROVEMENT FOR NEXT GENERATION CU/ULK INTERCONNECTS .....</b>   | 209 |
| Xun Gu ; Jiquan Liu ; Hao Deng ; Zheyuan Tong ; Jennifer Jing ; Beichao Zhang  |     |

|  |     |
|--|-----|
| <b>SPIN-BASED INTERCONNECT TECHNOLOGY AND DESIGN</b>   | 212 |
| <i>Azad Naeemi ; Sou-Chi Chang ; Sourav Dutta ; Chenyun Pan ; Sasikanth Manipatruni ; Dmitri Nikonov ; Ian Young</i> |     |
| <b>INTERCONNECT DESIGN FOR CONVENTIONAL AND EMERGING CHARGE-BASED DEVICES</b>  | 244 |
| <i>Azad Naeemi ; Chenyun Pan ; Divya Prasad</i>  |     |
| <b>BRAIN-INSPIRED INTERCONNECT ARCHITECTURES AND TECHNOLOGIES</b>  | 273 |
| <i>Jan M. Rabaey</i>   |     |
| <b>END OF CU ROADMAP AND BEYOND CU</b>   | 294 |
| <i>Zsolt Tőkei</i>   |     |
| <b>SILICON COMPATIBLE OPTICAL INTERCONNECTS</b>  | 323 |
| <i>Krishna Saraswat</i>  |     |
| <b>Author Index</b>  |     |