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ELECTRON DEVICES

meeting

2004

SAN FRANCISCO, CA
DECEMBER 13-15, 2004



Sponsored by Electron Devices Society of IEEE

TECHNICAL DIGEST

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WELCOME FROM THE GENERAL CHAIR

On behalf of the IEDM Committee, I would like to welcome you to the 2004 IEEE International Electron Devices Meeting. This marks our 50th annual conference for IEDM, and in recognition of this exciting occasion, special reception and historical poster session will be held on Monday evening. In addition, all of the conference attendees will receive a DVD containing the technical digest contents from the past 50 years. This impressive collection of material illustrates well the pivotal role IEDM has played as the leading forum for the presentation of research and development in the area of electron devices and their applications over the past half century.

The tradition is continuing this year, with a strong collection of invited and contributed papers from over 20 different countries, both from academia and industry. Over 640 abstracts were submitted in total this year, of which the committee accepted 230 for presentation at the conference. Short summaries of each abstract are included on the IEDM home page, and we encourage everyone to visit the site at:

<http://www.ieee.org/conference/iedm>

In addition to the regular paper sessions, the conference will again feature several special sessions:

On Sunday, two short courses are scheduled titled "45nm CMOS Technology" and "Devices for Next-Generation Digital Consumer Circuits and Systems". They are designed for broad appeal to IEDM participants, with material suitable for both newcomers as well as experts in the field. These courses have been organized by internationally known researchers and will be presented by people active in the respective topics.

The plenary session on Monday will feature a presentation looking back at the conference over the past few decades, "IEDM – a View as a Participant and a Customer," and two presentations looking forward to new challenges for the industry, "Future Semiconductor Manufacturing – Challenges and Opportunities" and "Emerging Technologies on Silicon," with speakers from North America, Asia and Europe.

The IEDM Tuesday Luncheon speaker this year will be Dr. Richard E. Smalley, Rice University professor and Nobel laureate. He will be speaking on "Our Energy Challenge", discussing the formidable task of supplying sufficient, sustainable, clean power to all of the world's people in the 21st century.

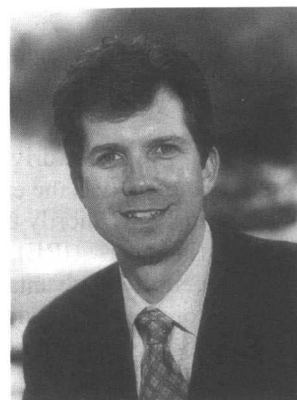
This year's Emerging Technologies session is titled "Nano-computing Devices." The six invited talks, delivered by experts in their respective fields, will cover a broad range of alternative technologies, ranging from molecules to spin devices to nano-mechanical structures, with a focus on understanding their potential for future logic and computation systems.

On Tuesday night, two timely and provocative panel discussions are planned: "What will end CMOS scaling – Money or Physics?" and, appropriately linked to extend the Emerging Technologies session discussions, "Nanoelectronics – Now or Never?"

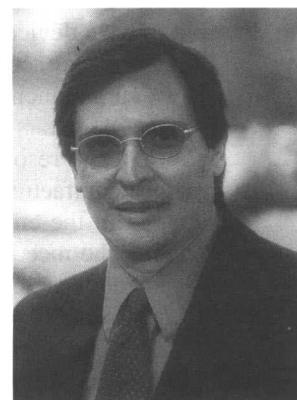
On behalf of the IEEE Electron Devices Society, which sponsors the IEDM, Jon Candelaria, Technical Program Chair and Kaizad Mistry, Technical Program Vice-chair, I wish to express my sincere appreciation to the members of the IEDM committee for the outstanding job they have done in planning and organizing the 2004 conference. Likewise, the authors are to be commended for their efforts in preparing and presenting the high-quality papers that form the foundation of the IEDM.

It is with great pleasure that I extend a warm welcome to everyone attending the 2004 IEEE International Electron Devices Meeting, and helping to celebrate our 50th year.

Jeffrey Welser
General Chair



Jeff Welser
General Chair



Jon Candelaria
Technical Program Chair



Kaizad Mistry
Technical Program Vice-Chair

The Beginnings of the IEDM

The following are the recollections of R.L. Pritchard, who was actively involved with the very first meetings of what would become the International Electron Devices Meeting:

The driving force for the creation of the Technical Meeting on Electron Devices, as it was then known, was the extremely rapid growth of the solid-state-device field, following the invention of the transistor in 1948. Shortly thereafter, a small device research conference was formed, sponsored by the Institute of Radio Engineers (IRE), one of the predecessors of the IEEE. This conference, which was by-invitation-only, permitted advantageous information interchange among the device-research workers in the field. However, as some of the device research graduated into the device-development arena, there was a need to be able to talk about results to a broader, but still specialized, audience.

Discussions about this need for a new meeting began in the early nineteen fifties with the officers of the IRE Professional Group on Electron Devices (PGED), with support from those with microwave-tube interests, and the concept of a general technical meeting of the IRE PGED emerged. The meeting was planned for two days, in Washington, DC, opening with a general session comprising invited papers, followed by a day and a half of three simultaneous sessions for contributed papers, respectively, on solid-state devices, microwave devices, and electron tubes in general. No exhibits or tutorial sessions were planned, and there were limited social activities; there was only a cocktail party followed by an informal dinner on the first evening. However, a luncheon with an invited speaker was planned for the first day.

The resources for making this meeting a reality came primarily from USA-based industry –e.g., the major manufacturers of electron tubes at that time – and from USA government agencies – which had a strong interest in the emerging solid-state device field as well as that of microwave tubes. (One of the reasons for holding the meeting in Washington, DC was the pool of volunteers available there.) No professional meeting organizers were employed; it was an all volunteer effort.

The first such meeting was held on 24-25 October 1955 (Thursday and Friday) and was very successful, with approximately 700 attendees, and a technical program with approximately 60 papers. Paper selection was done by a Technical Program Committee, with three subcommittees, one for each of the topics of the simultaneous sessions. For each of the nine sessions there was a Session Chair and a Session Organizer. Authors of the papers, for the most part, were from the same sources as cited above for the resources behind the meeting, although there were a few papers from academia.

After the success of the first EDM, it was clear that a need had been established for an annual meeting. Although international participation was welcomed, the first EDM Meetings were primarily USA oriented. Subsequently, the scope of the meetings became more global, and the name was changed to the International Electron Devices Meeting (IEDM).

R. L. Pritchard

Member, Technical Program Committee, First Meeting

Chair, Technical Program Committee, Second Meeting

AWARD PRESENTATIONS

PLENARY SESSION

Monday, December 13

2003 Roger A. Haken Best Student Paper Award: Yuan Xie, University of Michigan

For the paper entitled: "Novel UHF Micromechanical Extensional Wine-Glass Mode Ring Resonators"

Paul Rappaport Award: Ken Uchida, Junji Koga, Ryuji Ohba and Akira Toriumi, Toshiba Corporation

For the paper entitled: "Programmable Single-Electron Transistor Logic for Future Low-Power Intelligent LSI: Proposal and Room-Temperature Operation"

EDS George E. Smith Award: Tomohisa Mizuno, Naoharu Sugiyama, Tsutomu Tezuka and Shinichi Takagi

For the paper entitled: "(110) Strained-SOI n-MOSFETs with Higher Electron Mobility"

EDS Chapter of the Year Award: REL/CMPT/ED Singapore Chapter

"To an EDS chapter based on the quantity and quality of the activities and programs implemented by the chapter."

EDS Distinguished Service Award: Louis C. Parrillo, Parrillo Consulting, LLC

"To recognize and honor outstanding service to the Electron Devices Society."

EDS Graduate Student Fellowship Award: HongYu Yu, National University of Singapore and David John, University of British Columbia and Martin von Haartman, KTH, Royal Institute of Technology and David DiSanto, Simon Fraser University

"To promote, recognize, and support graduate level study and research within the Electron Devices Society's field of interest."

J.J. Ebers Award: Jerry Fossum, University of Florida

"For outstanding contributions to the advancement of SOI CMOS devices and circuits through modeling"

IEDM Luncheon

Tuesday, December 14

2004 IEEE Clelio Brunetti Award: Stephen Y. Chou, Princeton University

"For the invention and development of tools for nanoscale patterning, especially nanoimprint lithography and for the scaling of devices into new physical regimes"

2004 IEEE Andrew S. Grove Award: Krishna C. Saraswat, Stanford University

"For seminal contributions to silicon process technology"

2004 IEEE Daniel E. Noble Award: Larry J. Hornbeck, Texas Instruments

"For his pioneering work and sustained development of the Digital Micromirror Device, used in projection displays"

LUNCHEON PRESENTATION

Luncheon Presentation: "Our Energy Challenge", Professor Richard Smalley, Rice University

CONFERENCE HIGHLIGHTS

<u>Date</u>	<u>Time</u>	<u>Room</u>	<u>Event</u>
12/12	9:00 a.m. – 5:30 p.m.	Continental Ballrooms	Short Courses
12/13	9:00 a.m. – 12:00 p.m.	Continental Ballrooms	Plenary Session
12/13	6:30 p.m. – 9:00 p.m.	Grand Ballroom B	Reception
12/14	12:20 p.m. – 2:00 p.m.	Grand Ballroom B	Luncheon
12/14	8:00 p.m. – 10:00 p.m.	Continental Ballrooms	Panel Sessions

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Seated from left to right: Clark Nguyen, Emerging Technologies Chair; Melissa Widerkehr, Conference Manager; Kaizad Mistry, Technical Program Vice-Chair; Jeff Welser, General Chair; Jon Candelaria, Technical Program Chair; Veena Misra, Publications Chair; H.S. Philip Wong, 50th Anniversary Chair

First row standing from left to right: Coming Chen, Asian Arrangements Chair; Meikei Ieong, CMOS Devices Subcommittee Chair; Andrea Lacaita, European Arrangements Chair; Thomas Bonifield, Publicity Vice-Chair; Gaudenzio Meneghesso, Quantum Electronics and Compound Semiconductors Chair; Kazunari Ishimaru, Asian Arrangements Chair; Sandip Tiwari, Solid State Devices Chair; Phyllis Mahoney, Conference Manager

Second row standing from left to right: Thomas Skotnicki, European Arrangements Chair; Shou Gwo Woo, Detectors, Sensors and MEMS Subcommittee Chair; Paolo Pavan, CMOS and Interconnect Reliability Subcommittee Chair; Witek Maszara, Integrated Circuits and Manufacturing Subcommittee Chair; Ralf Brederlow, Short Course Vice-Chair; Cliff King, Publicity Chair; Mark Foisy, Modeling and Simulation Subcommittee Chair; Chris Auth, Process Technology Subcommittee Chair (Missing: Vivek Subramanian, Short Course Chair)

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Continental Ballroom 1-3

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SESSION 3: Integrated Circuits and Manufacturing – DRAM

Monday, December 13, 1:30 p.m.
Continental Ballroom 4

Co-Chairs: Luan Tran, Micron Technology
Harald Seidl, Infineon

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SESSION 4: Process Technology – Fully-Silicided (FUSI) Gates

Monday, December 13, 1:30 p.m.
Continental Ballroom 5

Co-Chairs: Jakub Kedzierski, IBM TJ Watson
Gyoyoung Jin, Samsung Electronics

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4.1 Advanced Gate Stacks with Fully Silicided (FUSI) Gates and High-k Dielectrics: Enhanced Performance at Reduced Gate Leakage , E.P. Gusev, C. Cabral, Jr., B.P. Linder, Y.H. Kim, K. Maitra, E. Cartier, H. Nayfeh*, R. Amos*, G. Biery, N. Bojarczuk, A. Callegari, R. Carruthers, S.A. Cohen, M. Copel, M.M. Frank, S. Fang*, S. Guha, M. Gribelyuk, P. Jamison, R. Jammy, M. Jeong, J. Kedzierski, P. Kozlowski, V. Ku*, D. Lacey, D. LaTulipe, V. Narayanan, H. Ng*, P. Nguyen*, J. Newbury, V. Paruchuri, R. Rengarajan*, G. Shahidi, A. Steegen*, M. Steen, S. Zafar and Y. Zhang, IBM SRDC, Yorktown Heights, NY and * IBM Microelectronic Division, Hopewell Junction, NY	79		
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4.2 Partial Silicides Technology for Tunable Work Function Electrodes on High-k Gate Dielectrics-Fermi Level Pinning Controlled PtSi_x for HfO₂ (N) pMOSFET , T. Nabatame, M. Kadoshima, K. Iwamoto, N. Mise, S. Migita*, M. Ohno, H. Ota*, N. Yasuda, A. Ogawa, K. Tominaga, H. Satake and A. Toriumi*, ASET, Tsukuba, Japan and *AIST, Tsukuba, Japan	83		
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4.4 Dual Workfunction Ni-Silicide/HfSiON Gate Stacks by Phase-Controlled Full-Silicidation (PC-FUSI) Technique for 45nm-node LSTP and LOP Devices , K. Takahashi, K. Manabe, T. Ikarashi, N. Ikarashi, T. Hase, T. Yoshihara, H. Watanabe, T. Tatsumi, and Y. Mochizuki, NEC Corporation, Kanagawa, Japan	91		
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4.6 Diffusion-less Junctions and Super Halo Profiles for PMOS Transistors Formed by SPER and FUSI Gate in 45 nm Physical Gate Length Devices , S. Severi, K. G. Anil, J. B. Pawlak*, R. Duffy*, K. Henson, R. Lindsay**, A. Lauwers, A. Veloso, J.-F. de Marneffe, J. Ramos, B. Sijmus, K. Devriendt, R.A. Camillo-Castillo^, P. Eyben, W. Vandervorst, M. Jurczak, S. Biesemans and K. De Meyer, IMEC, Leuven, Belgium, *Philips Research Leuven, Heverlee, Belgium and **Infineon, Munich, Germany and ^University of Florida, Gainesville, FL	99		
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Co-Chairs:	Muhammad Ashraful Alam, Purdue University		
	Samuel Pan, TSMC		
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Co-Chairs:	Mark Stettler, Intel		
	Enrico Sangiorgi, University of Bologna		
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