

5th Berkeley Symposium on Energy Efficient Electronic Systems & Steep Transistors Workshop

University of California, Berkeley, Sutardja Dai Hall, 3rd Floor, Banatao Auditorium

THURSDAY, OCTOBER 19, 2017

8:30 am REGISTRATON & BREAKFAST

9:15 am *Welcome Remarks*

Eli Yablonovitch & Jeffrey Bokor (University of California, Berkeley, USA)

9:30 am *Systems Benefits of Lower Operating Voltage*

Chairs: Jeffrey Bokor, Eli Yablonovitch, University of California, Berkeley, USA

9:30 am **Paolo Gargini** (IRDS, USA) *invited*

“Roadmap Evolution: From NTRS to ITRS, from ITRS 2.0 to IRDS”

9:50 am Questions & Discussion

9:55 am **Adrian Ionescu** (Ecole Polytechnique Fédérale Lausanne, Switzerland) *invited*

“Sub-unity Body Factor: The Next CMOS and Beyond CMOS Technology Booster for Enhanced Energy Efficiency?”

10:15 am Questions & Discussion

10:20 am **Subhasish Mitra** (Stanford University, USA) *invited*

“N3XT 3D Nanosystems for Energy-Efficient Abundant-Data Computing”

10:40 am Questions & Discussion

10:45 am **Takahiro Hanyu** (Tohoku University, Japan) *invited*

“Standby-Power-Free Integrated Circuits Using MTJ-Based VLSI Computing for IoT Applications”

11:05 am Questions & Discussion

11:10 am BREAK

11:25 am *Analog and Digital Accelerators for Deep Learning*

Chair: Eli Yablonovitch, University of California, Berkeley

11:25 am **Amir Khosrowshahi** (Intel Corporation, USA) *invited keynote*

Keynote Presentation: “Building a Platform for AI”

12:00 am Questions & Discussion

12:05 am **Engin Ipek** (University of Rochester, USA) and Mahdi Nazm Bojnordi (University of Utah, USA) *invited*

“Memristive Boltzmann Machine: A Hardware Accelerator for Combinatorial Optimization and Deep Learning”

12:25 pm Questions & Discussion

ADVANCE PROGRAM 10-16

12:30 pm LUNCH

1:30 pm Steep Tunnel Transistors for Reduced Operating Voltage

Chair: Lars-Erik Wernersson, Lund University

- 1:30 pm **Alan Seabaugh** (University of Notre Dame, USA) *invited*
“Advance of Steep Transistors”
- 1:50 pm Questions & Discussion
- 1:55 pm **Shinichi Takagi**, Daehwan Ahn, Takahiro Gotow, Koichi Nishi, Taeon Bae, Takumi Katoh, Ryo Matsumura, Ryotaro Takaguchi, Kimihiko Kato and Mitsuru Takenaka (University of Tokyo, Japan) *invited*
“III-V/Ge-based Tunneling MOSFET”
- 2:15 pm Questions & Discussion
- 2:20 pm **Ru Huang**, Qianqian Huang, Yang Zhao, Cheng Chen, Rundong Jia, Lingyi Guo and Yangyuan Wang (Peking University, China) *invited*
“Steep Switch with Hybrid Operation Mechanism for Performance Improvement”
- 2:40 pm Questions & Discussion
- 2:45 pm **Peter Asbeck** and Jie Ming (University of California, San Diego, USA)
“Modeling the Influence of Dielectric Interface Traps on I-V Characteristics of TFETs”
- 3:00 pm Questions & Discussion

3:05 pm BREAK

3:20 pm Strategies for Neuromorphic Computing

Chair: Jeffrey Bokor, University of California, Berkeley

- 3:20 pm **Yichen Shen**, Nicholas C. Harris, Dirk Englund and Marin Soljagic (Massachusetts Institute of Technology, USA) *invited*
“Deep Learning with Coherent Nanophotonic Circuits”
- 3:40 pm Questions & Discussion
- 3:45 pm **Shunsuke Fukami**, William Borders, Aleksandr Kurenkov, Chaoliang Zhang, Samik Dutttagupta and Hideo Ohno (Tohoku University, Japan) *invited*
“Use of Analog Spintronics Device in Performing Neuro-morphic Computing Functions”
- 4:05 pm Questions & Discussion
- 4:10 pm **Sapan Agarwal**, Alexander Hsia, Robin Jacobs-Gedrim, David R. Hughart, Steven J. Plimpton, Conrad D. James and Matthew Marinella (Sandia National Laboratories, USA) *invited*
“Designing an Analog Crossbar-based Neuromorphic Accelerator”
- 4:30 pm Questions & Discussion
- 4:35 pm **Masanao Yamaoka** (Hitachi Ltd., Japan) *invited*
“An Ising Computing to Solve Combinatorial Optimization Problems”
- 4:55 pm Questions & Discussion

ADVANCE PROGRAM 10-16

5:00 pm **BREAK**

5:10 pm **Panel Discussion on Deep Learning and Neural Networks**

Moderator: Jan Rabaey, University of California, Berkeley

Panelists: Amir Khosrowshahi, Engin Ipek, Masanao Yamaoka, Yichen Shen, Shunsuke Fukami, Sapan Agarwal

5:50 pm **WALK TO POSTER SESSION**

6:00 pm **Poster Session & Reception**

8:00 pm **END OF DAY 1**

FRIDAY, OCTOBER 20

8:45 am **BREAKFAST (& REGISTRATION)**

9:30 am **Negative Capacitance Transistors**

Chair: Sayeef Salahuddin, University of California, Berkeley

9:30 am **Masaharu Kobayashi** (University of Tokyo, Japan) *invited*
“Technology Breakthrough by Ferroelectric HfO₂ for Ultralow Power Logic and Memory”

9:50 am Questions & Discussion

9:55 am **Zoran Krivokapic**, Ahmedullah Aziz, Da Song, Uzma Rana, Rohit Galatage and Srinivasa Banna (GlobalFoundries, USA) *invited*
“NCFET: Opportunities & Challenges for Advanced Technology Nodes”

10:15 am Questions & Discussion

10:20 am **BREAK**

10:30 am **Ultrafast Magnetic Switching**

Chair: Eli Yablonovitch, University of California, Berkeley

10:30 am **Jeffrey Bokor** (University of California, Berkeley, USA) *invited*
“Prospects for Ultrafast MRAM with <10 psec Write Latency”

10:50 am Questions & Discussion

10:55 am **Lucian Prejbeanu**, Andrey Timopheev, Ricardo Sousa, Gilles Gaudin and Bernard Dieny (SPINTEC, CEA Grenoble, France) *invited*
“Ultrafast MRAM Strategies for Cache Applications and Beyond”

11:15 am Questions & Discussion

ADVANCE PROGRAM 10-16

11:20 am **Adaptive Neural Networks**

Chair: Eli Yablonovitch, University of California, Berkeley

11:20 am **Gert Cauwenberghs** (University of California, San Diego, USA) *invited*
"Energy Efficiency in Adaptive Neural Circuits"

11:40 am Questions & Discussion

11:45 am **LUNCH**

12:45 pm **New Mechanisms for Energy Efficient Computing**

Chair: Nerissa Draeger, Lam Research

12:45 pm **Farnaz Niroui**, Jatin Patil, Timothy Swager, Jeffrey Lang and Vladimir Bulovic (Massachusetts Institute of Technology, USA)
"Towards Low-Stiction Nanoelectromechanical Switches Using Self-Assembled Molecules"

1:00 pm Questions & Discussion

1:05 pm **Vladimir Stojanovic**,¹ Sajjad Moazeni,¹ Amir Atabaki,² Fabio Pavanello,³ Hayk Gevorgyan,⁴ Jelena Notaros,² Luca Alloatti,² Mark Wade,⁵ Chen Sun,⁵ Seth Kruger,⁶ Huaiyu Meng,² Kenaish Al Qubaisi,⁴ Imbert Wang,⁴ Bohan Zhang,⁴ Anatol Khilo,⁴ Christopher Baicco,⁶ Milos Popovic,⁴ and Rajeev Ram² (¹University of California, Berkeley, USA, ²Massachusetts Institute of Technology, USA, ³Ghent University-IMEC, Belgium, ⁴Boston University, USA, ⁵Ayar Labs, Inc., USA, ⁶SUNY Polytechnic Institute, USA)
"Integration of Polysilicon-based Photonics in a 12-inch Wafer 65nm Bulk CMOS Process"

1:20 pm Questions & Discussion

1:25 pm **Seth Fortuna**, Christopher Heidelberger, Nicolas Andrade, Kevin Han, Eugene Fitzgerald, Eli Yablonovitch and Ming Wu (University of California, Berkeley and Massachusetts Institute of Technology, USA)
"Large Spontaneous Emission Rate Enhancement in a Nanoscale III-V LED Coupled to an Optical Antenna"

1:40 pm Questions & Discussion

1:45 pm **BREAK**

1:55 pm **Defects and Energy Level Characteristics of Tunnel Transistors**

Chair: Alan Seabaugh, University of Notre Dame

1:55 pm **Jesus del Alamo**, Xin Zhao, Lu Wenjie and Vardi Alon (Massachusetts Institute of Technology, USA) *invited*
"Towards Sub-10 nm Diameter InGaAs Vertical Nanowire MOSFETs and TFETs"

2:15 pm Questions & Discussion

2:20 pm **Lars-Erik Wernersson** (Lund University, Sweden) *invited*
"III-V Nanowire TFETs: Performance, Statistics, and Band Edge Sharpness"

2:40 pm Questions & Discussion

ADVANCE PROGRAM 10-16

- 2:45 pm **Anne Verhulst**,¹ Devin Verreck,¹ William G. Vandenberghe,² Quentin Smets,¹ Mazharuddin Mohammed,^{1,3} Jasper Bizindavyi,^{1,3} Marc M. Heyns,^{1,3} Bart Soree,^{1,3,4} Nadine Collaert,¹ and Anda Mocuta¹ (¹IMEC, Leuven, Belgium, ²Univ. of Texas at Dallas, USA, ³KU Leuven, Belgium, ⁴UAntwerp, Belgium) *invited*
“Inherent Transmission Probability Limit Between Valence-band and Conduction-band States and Calibration of Tunnel-FET Parasitics”
Questions & Discussion
- 3:05 pm **Felix Fischer** (University of California, Berkeley, USA)
3:10 pm *“Graphene Nanoribbon Band Gap Engineering Through Orbitally Matched Dopant Atoms”*
Questions & Discussion
- 3:25 pm **Sheikh Ahmed**, Yaohua Tan, Daniel Truesdell and Avik Ghosh (University of Virginia, USA)
3:30 pm *“Auger Effect Limited Performance in Tunnel Field Effect Transistors”*
Questions & Discussion
- 3:45 pm
- 3:50 pm** **Closing Remarks**
Eli Yablonovitch & Jeffrey Bokor (University of California, Berkeley, USA)
- 4:00 pm** **END OF SYMPOSIUM**