ADVANCE PROGRAM 10-16

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

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, Taeeon 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 Soljacic (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 Duttagupta 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

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 (for list of posters see below)***

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

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 Ram[2] ([1]University of California, Berkeley, USA, [2]Massachusetts Institute of Technology, USA, [3]Ghent University-IMEC, Belgium, [4]Boston University, USA, [5]Ayar Labs, Inc., USA, [6]SUNY 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 Insitute 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

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 Mocuta[1] ([1]IMEC, Leuven, Belgium, [2]Univ. of Texas at Dallas, USA, [3]KU Leuven, Belgium, [4]UAntwerp, Belgium) *invited*
"Inherent Transmission Probability Limit Between Valence-band and Conduction-band States and Calibration of Tunnel-FET Parasitics"

3:05 pm Questions & Discussion

3:10 pm **Felix Fischer** (University of California, Berkeley, USA)
"Graphene Nanoribbon Band Gap Engineering Through Orbitally Matched Dopant Atoms"

3:25 pm Questions & Discussion

3:30 pm **Sheikh Ahmed**, Yaohua Tan, Daniel Truesdell and Avik Ghosh (University of Virginia, USA)
"Auger Effect Limited Performance in Tunnel Field Effect Transistors"

3:45 pm Questions & Discussion

3:50 pm ***Closing Remarks***

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

4:00 pm **END OF SYMPOSIUM**

LIST OF POSTERS

Authors	Poster Title
Jasper Bizindavyi, Anne S. Verhulst, Quentin Smets, Devin Verreck, Nadine Collaert, Anda Mocuta, Bart Sorée and Guido Groeseneken	*Calibration of the high-doping induced ballistic band-tails tunneling current with In0.53Ga0.47As Esaki diodes*
Sarthak Gupta, Kaushal Nigam, Sunil Pandey, Dheeraj Sharma and Pravin Kondekar	*Performance Improvement of Heterojunction Double Gate Drain Overlapped TFET using Gaussian Doping*
Dheeraj Sharma, Bhagwan Ram Raad and Sukeshni Tirkey	*Channel Engineered Tunnel FET for Reduced Ambipolar Nature*
Jon Gorchon, Charles-Henri Lambert, Yang Yang, Akshay Pattabi, Sayeef Salahuddin and Jeffrey Bokor	*Single shot ultrafast all optical magnetization switching of ferromagnetic Co/Pt multilayers*
Stefan Glass, Christian Schulte-Braucks, Lidia Kibkalo, Uwe Breuer, Jean-Michel Hartmann, Dan Buca, Siegfried Mantl and Qing-Tai Zhao	*Examination of a new SiGe/Si heterostructure TFET concept based on vertical tunneling*
Rebecca Durr, Danny Haberer, Yea-Lee Lee, Alin Miksi Kalayjian, Raymond Blackwell, Tomas Marangoni, Steven Louie and Felix Fischer	*Graphene Nanoribbon Band Gap Engineering Through Orbitally Matched Dopant Atoms.*
Zhifu Liu, Peter Girouard, Pice Chen, Young Kyu Jeong, Seng-Tiong Ho and Bruce W. Wessels	*50 GHz Electro-optic Modulators with BaTiO3 Epitaxial Thin Film Platform for Short Distance Optical Communications*
Francesco Settino, Sebastiano Strangio, Marco Lanuzza, Felice Crupi, Pierpaolo Palestri and David Esseni	*Simulations and comparisons of basic analog and digital circuit blocks employing Tunnel FETs and conventional FinFETs*
Yasmine Elogail, Joerg Schulze and Inga Fischer	*Fabrication and Simulation of Vertical Ge-based P-Channel Planar-Doped Barrier FETs with 40 nm Channel Length*
Shaloo Rakheja and Kexin Li	*Graphene-Based Plasma Wave Interconnects for On-Chip Communication in the Terahertz Band*
Jun Huang, Pengyu Long, Michael Povolotskyi, Gerhard Klimeck and Mark Rodwell	*Sb- and Al- Free Ultra-High-Current Tunnel FET Designs*

Hongjuan Wang, Xiangwei Jiang, Genquan Han, Yue Hao, Shushen Li and David Esseni	*Revisiting Piezoelectric FETs with Sub-Thermal Swing*
Pin-Chun Shen and Jing Kong	*Chemical Vapor Deposition of High-Quality Monolayer Transition Metal Disulfides*
Sajjad Moazeni, Amir Atabaki, Fabio Pavanello, Hayk Gevorgyan, Jelena Notaros, Luca Alloatti, Mark Wade, Chen Sun, Seth Kruger, Huaiyu Meng, Kenaish Al Qubaisi, Imbert Wang, Bohan Zhang, Anatol Khilo, Christopher Baicco, Milos Popovic, Rajeev Ram and Vladimir Stojanovic	*Integration of Polysilicon-based Photonics in a 12-inch Wafer 65nm Bulk CMOS Process*
Bivas Saha, Benjamin Osoba, Tsu Jae King Liu and Junqiao Wu	*Materials Engineering of Micro-relay Contact Surfaces for milli-Volt Switching*
Sri Krishna Vadlamani and Eli Yablonovitch	*On the broadening of energy levels in a quantum dot-based tunnel transistor*
Nishtha Sharma, Andrew Marshall, Jonathan Bird and Peter Dowben	*Verilog-A based Compact Modeling of the Magneto-electric FET Device*
Nishtha Sharma, Andrew Marshall, Jonathan Bird and Peter Dowben	*Novel Ring Oscillator Design Using ME-MTJ Based Devices*
William Vandenberghe	*Two-dimensional Topological Insulator Transistors as Energy Efficient Switches Robust against Material and Device Imperfections*
Ting Cao, Fangzhou Zhao, Yea-Lee Lee and Steven G. Louie	*Graphene Nanoribbons for Transistor Applications*
Taeeon Bae, Ryota Suzuki, Ryosho Nakane, Mitsuru Takenaka and Shinichi Takagi	*Effects of Ge-source impurity concentration on electrical characteristics of Ge/Si hetero-junction tunneling FETs*
Jean Anne Incorvia, Elyse Barre, Suk Hyun Kim, Connor McClellan, Eric Pop, H.-S. Philip Wong and Tony Heinz	*Near-room temperature electrical control of spin and valley Hall effect in monolayer WSe2 transistors for spintronic applications*
Sean Hooten and Eli Yablonovitch	*Metallodielectric Antenna for Spontaneous Emission Enhancement*
Sergio Almeida, David Zubia, Aldo Vidaña and Mariana Martinez	*Conductance Modulation in 2D Materials by NEMS for Lower-Power Applications*

Amal El-Ghazaly, Daisy O'Mahoney, Charles-Henri Lambert, Jon Gorchon, P. Nigel Brown, Akshay Pattabi, H.S. Philip Wong and Jeffrey Bokor	*Ultrafast Magnetic Memory Bits Using All-Optical Magnetic Switching*
Nicolas Andrade, Seth Fortuna, Kevin Han, Sean Hooten, Eli Yablonovitch and Ming Wu	*Efficient and Broadband Single-Mode Waveguide Coupling of Electrically Injected Optical Antenna Based nanoLED*
Brayan Navarrete, Mark Stone and Sakhrat Khizroev	*Properties of Magnetic Tunneling Junction Devices with Characteristic Sizes in Sub-5-nm Range*
Samuel Xavier-De-Souza, Eduardo Neves, Alex Furtunato, Luiz Silveira, Kyriakos Georgiou and Kerstin Eder	*The Benefits of Low Operating Voltage Devices to the Energy Efficiency of Parallel Systems*
Peida Zhao, Matin Amani, Der-Hsien Lien, Geun Ho Ahn, Daisuke Kiriya, James P. Mastandrea, Joel W. Ager, Eli Yablonovitch, Daryl C. Chrzan and Ali Javey	*Measuring the Edge Recombination Velocity of Monolayer Semiconductors*
Mirza M. Elahi, K. M. Masum Habib and Avik W. Ghosh	*Gate tunable transport-gap to beat the Boltzmann limit: a Graphene Klein Tunnel Field Effect Transistor*
Zhixin Alice Ye, Hei Kam and Tsu-Jae King Liu	*Negative Stiffness Structures for Energy Efficient MEM Switches*
Matin Amani, Der-Hsien Lien, Daisuke Kiriya, Geun Ho Ahn, Peida Zhao, Joel Ager, Eli Yablonovitch and Ali Javey	*High Photoluminescence Quantum Yield in Transition Metal Dichalcogenides Enabled by Superacid Treatment*
Sreetosh Goswami and T. Venkatesan	*Resistive Memory Devices using Metal-Coordinated Azo-aromatics*