SYMPOSIUM ED11

Phase-Change Materials and Their Applications—Memories, Photonics, Displays and Non-von Neumann Computing
April 18 - April 21, 2017

Symposium Organizers
Harish Bhaskaran, University of Oxford
Eric Pop, Stanford University
Stefania Privitera, Consiglio Nazionale delle Ricerche (CNR)
Yuta Saito, National Institute of Advanced Industrial Science and Technology (AIST)

Proceedings Statement
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* Invited Paper

TUTORIAL
Materials and Device Optimization for Phase-Change-Based Applications

Monday Morning, April 17, 2017
8:30 AM – 2:45 PM
PCC North, 100 Level, Room 131 C

The tutorial is aimed to give an overview of materials engineering and device optimization for relevant emerging applications, such as phase change memories, non-von Neumann computing, and optoelectronics.

8:30 AM - 9:45 AM
Part I: **Huai-Yu Cheng**

Part I will be presented by H. Y. Cheng and will give a comprehensive overview of the materials properties for phase change memories, with a focus on materials engineering for high temperature applications and for ultra-fast switching.

9:45 AM BREAK

10:15 AM - 11:30 AM
Part II: **Abu Sebastian**

In Part II A. Sebastian will show how chalcogenide-based phase change materials can be used for non-von Neumann computing such as brain-inspired neuromorphic computing and memcomputing.

11:30 AM LUNCH

1:30 PM - 2:45 PM
Part III: **Dan Hewak**

Part III, presented by Prof. D. Hewak, will be focused on the employment of chalcogenide phase change materials for optoelectronics applications.

Instructors
Huai-Yu Cheng, IBM/Macronix PCRAM Joint Project, Macronix Int. Co., Ltd.
Abu Sebastian, IBM Research—Zurich
Dan Hewak, University of Southampton

SESSION ED11.1: Structure and Stability
Session Chairs: Raffaella Calarco and Wei Zhang
Tuesday Morning, April 18, 2017
PCC North, 100 Level, Room 131 C

10:30 AM *ED11.1.01
Theoretical Prospects for Two-Dimensional Phase Change Materials Evan J. Reed; Stanford University, United States.

11:00 AM ED11.1.02
The Structural Origins of the Non-Resonantly Bonded Phase-Change Material Ga_2Te_3 Paul Fons[1, 2]; [1]National Institute of Advanced Industrial Science and Technology (AIST), Japan; [2]Japan Synchrotron Radiation Institute SPring-8, Japan.

11:15 AM ED11.1.03
Glass Transitions, Semiconductor-Metal (SC-M) Transitions and Fragilities in Ge-V-Te (V=As, or Sb) Liquid Alloy—The Difference One Element Can Make Shuai Wei; Arizona State University, United States.

11:30 AM ED11.1.04
Copper-Doped Chalcogen Glasses for Access Devices Applications—A First-Principles Study David Guzman; Purdue University, United States.

SESSION ED11.2: Correlation between Structure and Properties
Session Chairs: Raffaella Calarco and Stefania Privitera
Tuesday Afternoon, April 18, 2017
PCC North, 100 Level, Room 131 C

1:30 PM *ED11.2.01
Structural and Electronic Properties of Ultrathin Films of Phase-Change Materials Ider Ronneberger[1, 2]; [1]RWTH Aachen University, Germany; [2]RWTH Aachen University, Germany.

2:00 PM ED11.2.02
Metal-Insulator Transition and Carrier Dynamics in GeSbTe Phase Change Materials Investigated via Electrical Transport, Terahertz and Raman Spectroscopy Valeria Bragaglia; Paul Drude Institute, Germany.

2:15 PM *ED11.2.03
Nanoscale Characterization of Crystalline Phase-Change Materials for Novel Applications Antonio M. Mio; RWTH Aachen University, Germany.

2:45 PM ED11.2.04
Atomic Defects in Hexagonal GeSbTe Compound Wei Zhang; Xi'an Jiaotong University, China.

3:00 PM BREAK

SESSION ED11.3: Memories and Thermal Effects
Session Chairs: Daniele Ielmini and Veronique Sousa
Tuesday Afternoon, April 18, 2017
PCC North, 100 Level, Room 131 C

3:30 PM *ED11.3.01
Thermoelectric Effects in Confined Phase Change Memory Devices Nicola Ciocchini; Intel Corp, United States.

4:00 PM ED11.3.02
Electrothermal-Dynamic Granular Materials Modeling of Phase Change Memory and Logic Devices Ali Gokirmak; University of Connecticut, United States.

4:15 PM ED11.3.03
Thermal Modelling of Phase Change Memory Cells for Extraction of the Cell Temperature during Crystallization Faruk Dirisaglik; Eskisehir Osmangazi University, Turkey.

4:30 PM ED11.3.04
Atomic Diffusion in Laser Irradiated Ge Rich GeSbTe Thin Films Stefania M. Privitera; Consiglio Nazionale delle Ricerche, Italy.

SESSION ED11.4: Poster Session
Session Chairs: Harish Bhaskaran and Stefania Privitera
Tuesday Afternoon, April 18, 2017
8:00 PM - 10:00 PM
Sheraton, Third Level, Phoenix Ballroom

ED11.4.01
Seebeck Coefficient, Electrical Resistivity and Derived Thermal Conductivity of $Ge_2Sb_2Te_5$ Thin Films Lhacene Adnane; University of Connecticut, United States.

ED11.4.02
Insights for Crystalline Phase-Change Materials from Computational Studies of Colloidal Crystals Chrisy Xiyu Du; University of Michigan, United States.

ED11.4.03
Computational Analysis of High Carrier Generation and Its Impact on the Melting and Thermoelectric Effects in Semiconductor Devices Sadid Muneer; University of Connecticut, United States.

ED11.4.04
Vanadium Dioxide Nanowire Crossbar Bo Hsu; University of Illinois at Chicago, United States.

ED11.4.05
Enhanced Electrical Switching in Strain Engineered Sb_2Te_3-GeTe Interfacial Phase Change Memory Cells Xilin Zhou; Singapore University of Technology and Design, Singapore.

ED11.4.06
An Effect of Various Electrode Materials for Electrical Characteristics of the Ovonic Threshold Switching (OTS) Devices Using the Ge-Se Binary Amorphous Chalcogenide Hyung-Woo Ahn; ULVAC, Japan.

SESSION ED11.5: Threshold Switching and Devices
Session Chairs: Stefania Privitera and Veronique Sousa
Wednesday Morning, April 19, 2017
PCC North, 100 Level, Room 131 C

8:00 AM *ED11.5.01
Picosecond Electric-Field-Induced Threshold Switching in Phase-Change Materials Aaron Lindenberg[1, 2]; [1]Stanford University, United States; [2]SLAC National Accelerator Laboratory, United States.

8:30 AM *ED11.5.02
Ultrafast Electrical Switching Dynamics in Phase-Change Materials Anbarasu Manivannan[1, 2]; [1]Indian Institute of Technology Indore, India; [2]Indian Institute of Technology Indore, India.

9:00 AM ED11.5.03
Impact of Ge-Sb-Te Material Engineering for Fast-Switching Phase Change Memory Huai-Yu Cheng; Macronix International Co., Ltd., United States.

9:15 AM ED11.5.04
Composition Control of CVD $Ge_xSb_yTe_z$ for Low-Reset Current, Fast-Switching Phase Change Memory Fabio Carta; IBM T. J. Watson Research Center, United States.

9:30 AM ED11.5.05
Transport Properties and Temperature Dependence of Threshold Switching and Self-Oscillation in NbO_x Based Devices Shuai Li; Australian National University, Australia.

9:45 AM BREAK

SESSION ED11.6: Device Reliability
Session Chairs: Huai-Yu Cheng and Anbarasu Manivannan
Wednesday Morning, April 19, 2017
PCC North, 100 Level, Room 131 C

10:15 AM *ED11.6.01
Suppressing Drift and Crystallization in Phase Change Memory Operated in Bipolar Mode Daniele Ielmini; Politecnico di Milano, Italy.

10:45 AM *ED11.6.02
An Insight into the High Temperature Reliability of Ge-Rich and N-Doped GeSbTe Phase Change Memory Devices Veronique Sousa; CEA LETI MINATEC, France.

11:15 AM ED11.6.03
Short and Long Time Resistance Drift Measurement in Intermediate States of $Ge_2Sb_2Te_5$ Phase Change Memory Line Cells Nafisa Noor; University of Connecticut, United States.

11:30 AM ED11.6.04
Analysis of Resistance State Stability in Ge-Rich PCM Devices under Voltage and Temperature Stress Julia Kluge[1, 2, 3]; [1]STMicroelectronics, France; [2]CEA LETI, France; [3]IMEP-LAHC, Minatec/INPG, France.

11:45 AM ED11.6.05
Improving Phase Change Material-Based RF Switch Reliability via In Depth Morphological Analysis Matt King[1, 2]; [1]Northrop Grumman, United States; [2]North Carolina State University, United States.

SESSION ED11.7: Emerging Applications and Devices
Session Chairs: Stefania Privitera and Abu Sebastian
Wednesday Afternoon, April 19, 2017
PCC North, 100 Level, Room 131 C

1:30 PM ED11.7.01
A Study on Stochasticity in Hexagonal Close Packed $Ge_2Sb_2Te_5$ Nanowires for Possible Physical Unclonable Function (PUF) Implementation Raihan Sayeed Khan; University of Connecticut, United States.

1:45 PM ED11.7.02
Thermal Probe Lithography of GeTe Thin Films Laura Ruppalt; US Naval Research Laboratory, United States.

2:00 PM ED11.7.03
Mechanical and Electrical Characterization of CVD-Grown Graphene Transferred on Chalcogenide Phase Change Materials Giuseppe D'Arrigo; CNR-IMM HQ, Italy.

2:15 PM ED11.7.04
Ultra-Low Resistance Sn-Based Contacts to GeTe Hamed Simchi; Pennsylvania State University, United States.

2:30 PM BREAK

SESSION ED11.8/ED2.6: Joint Session: Devices for Neuromorphic Computation
Session Chairs: Daniele Ielmini and Shimeng Yu
Wednesday Afternoon, April 19, 2017
PCC North, 100 Level, Room 131 C

3:30 PM *ED11.8.01/ED2.6.01
The N3XT Technology for Brain-Inspired Computing H.-S. Philip Wong; Stanford University, United States.

4:00 PM ED11.8.02/ED2.6.02
Low Voltage Nano-Ionics Based Selector Devices Using Doped HfO_2 for Application in 3D Crosspoint Memories Sushant S. Sonde[1, 2]; [1]Institute for Molecular Engineering, University of Chicago, United States; [2]Argonne National Laboratory, United States.

4:15 PM ED11.8.03/ED2.6.03
Finite Element Modeling of Ovonic Threshold Switch Controlled Phase Change Memory Devices Jacob Scoggin; University of Connecticut, United States.

SESSION ED11.9: Epitaxial Films and Superlattices
Session Chairs: Kirill Mitrofanov and Yuta Saito
Thursday Morning, April 20, 2017
PCC North, 100 Level, Room 131 C

8:30 AM *ED11.9.01
Epitaxial Ultra-Thin GeTe Films Raffaella Calarco; Paul-Drude-Inst, Germany.

9:00 AM ED11.9.02
Precise Control of the In-Plane Lattice Parameter in $Sb_{2+x}Te_3$/GeTe Superlattices Stefano Cecchi; Paul-Drude-Institut für Festkörperelektronik, Germany.

9:15 AM ED11.9.03
Controlling the Epitaxy of 2D Bonded Sb_2Te_3 and 3D Bonded GeTe on Si(111) Jamo Momand; University of Groningen, Netherlands.

9:30 AM BREAK

SESSION ED11.10: Interfacial Phase Change Memories
Session Chairs: Paul Fons and Yuta Saito
Thursday Morning, April 20, 2017
PCC North, 100 Level, Room 131 C

10:00 AM *ED11.10.01
Designing Phase Change Memory Materials Robert E. Simpson; SUTD, Singapore.

10:30 AM ED11.10.02
Design of Highly C-Axis Oriented Bismuth Chalcogenides for Strain Engineered Interfacial Phase Change Memory Xilin Zhou; Singapore University of Technology and Design, Singapore.

10:45 AM *ED11.10.03
Femtosecond Optical Responses from Topological Phase-Change Materials Muneaki Hase[1,2]; [1]University of Tsukuba, Japan; [2]CREST, Japan Science and Technology Agency, Japan.

11:15 AM ED11.10.04
New Insight on Long Range and Local Orders of GeTe/Sb_2Te_3 Superlattices Philippe Kowalczyk; CEA-Leti, France.

11:30 AM ED11.10.05
High-Endurance High-Speed Bipolar Switching of Sputtered GeTe/Sb_2Te_3 Superlattice iPCM Kirill V. Mitrofanov; National Institute of Advanced Industrial Science and Technology (AIST), Japan.

SESSION ED11.11: Photonics
Session Chairs: Robert Simpson and Rashid Zia
Thursday Afternoon, April 20, 2017
PCC North, 100 Level, Room 131 C

1:30 PM *ED11.11.01
Tunable Micro- and Nano-Structured Optical Devices Using Phase-Cange Materials Miquel Rude; ICFO–The Institute of Photonic Sciences, Spain.

2:00 PM ED11.11.02
Phase-Change GeTe for Tunable Photonic Applications Kyung-Ah Son; HRL Laboratories, United States.

2:15 PM ED11.11.03
Tuneable Gap-Plasmonic Optical Antennas Enabled by Phase Change Materials Weiling Dong; Singapore University of Technology and Design, Singapore.

2:30 PM BREAK

SESSION ED11.12: Optical Devices
Session Chairs: Harish Bhaskaran and Rashid Zia
Thursday Afternoon, April 20, 2017
PCC North, 100 Level, Room 131 C

3:00 PM *ED11.12.01
Solid State Reflective Displays (SRD) Peiman Hosseini; Bodle Technologies, United Kingdom.

3:30 PM ED11.12.02
Coding Two-Dimensional Images into Mode Spectrum of Silicon Microcavity Covered with a Phase-Change Layer Toshiharu Saiki; Keio University, Japan.

3:45 PM ED11.12.03
Phase-Change Films for Thermally-Tunable Ultrasensitive Infrared Absorption Spectroscopy Gokhan Bakan; Bilkent University, Turkey.

4:00 PM ED11.12.04
Tunable Dielectric Metadevices Enabled by Phase-Change Materials Arseny Alexeev; University of Exeter, United Kingdom.

SESSION ED11.13: Optical Devices Based on VO_2
Session Chairs: Harish Bhaskaran and Peiman Hosseini
Friday Morning, April 21, 2017
PCC North, 100 Level, Room 131 C

8:30 AM *ED11.13.01
Modulating Emission at Sub-Lifetime Speeds: Phase-Change Materials for High-Speed Sources Rashid Zia; Brown University, United States.

9:00 AM ED11.13.02
Probing Metal-Insulator Transitions in VO_2 with Ultra-Narrow Carbon Nanotube Electrodes Stephanie Bohaichuk; Stanford University, United States.

9:15 AM ED11.13.03
Electro-Thermal Control of Vanadium Dioxide Multilayered Thin Film Phase Change Material by Degenerate Semiconductor for Smart-Device Applications Aswini Pradhan; Norfolk State University, United States.

9:30 AM BREAK

10:00 AM ED11.13.04
Electrochemically Induced Insulator-Metal-Insulator Transformations of Vanadium Dioxide Nanocrystal Films Clayton J. Dahlman; University of Texas at Austin, United States.

10:15 AM ED11.13.05
Antenna-Assisted Picosecond Control of Nanoscale Phase-Transition in Vanadium Dioxide Otto L. Muskens; University of Southampton, United Kingdom.

10:30 AM ED11.13.06
Control of Phase Transition Properties of Vanadium Dioxide Thin Film for Thermal Biosensor Soo Deok Han[1,2]; [1]Korea Institute of Science and Technology, Korea (the Republic of); [2]Korea University, Korea (the Republic of).

10:45 AM ED11.13.07
Thermal Transistor Based on the Hysteresis of VO_2 Jose Ordonez-Miranda; Institut Pprime CNRS, France.