

John Rozen

Curriculum Vitae

Birth Date : May 3rd, 1980 Citizenship : Belgium, EU Immigration Status : JP Work Visa, US Permanent Resident

Qualifications and Objectives J. Rozen is a Research Staff Member at the IBM T. J. Watson Research Center, located in Yorktown Heights, New York. He has degrees in Engineering, Physics, and Materials Science. The interdisciplinary nature of his curriculum has allowed him to develop a wide range of skills that have been successfully applied to research on material properties including dielectric/semiconductor interface characterization in wide band gap SiC devices, development of alternate gate stacks for Si CMOS technology scaling, and thin film deposition for opto-electronic applications. His achievements include the design, implementation, and automation of processing and testing setups, talks at international conferences, successful interactions with funding agencies, publications in peer-reviewed journals, and patent submissions. His previous experiences have proven that he is a fast and versatile learner, a patient and effective teacher, and that he is dedicated to the quality of his work. He aspires to further strengthen his knowledge in a multidisciplinary environment.

Current

<i>Position</i>	Research Staff Member, Research & Development, IBM T. J. Watson Research Center, Yorktown Heights, New York, USA.
<i>Fields</i>	Materials Science, Physics, Engineering
<i>Project</i>	Alternate gate stacks for CMOS, Semiconductor Devices and Interface Physics - Fabrication and Characterization.

Education

2005 – 2008	Ph.D. in Materials Science Program, Vanderbilt University, Nashville TN, USA. Thesis Title: <i>Electronic Properties and Reliability of the SiO₂/SiC Interface</i> . Graduation Date: May 2008
2003 – 2005	M.S. in Materials Science Program, Vanderbilt University, Nashville TN, USA. Thesis Title: <i>Properties of Nanocrystalline Vanadium Dioxide</i> . Graduation Date: December 2005
2002 – 2003	D.E.A. (M.S. equivalent) in Physics Program, Université Libre de Bruxelles, Brussels, BE. Graduation Date: June 2003
2000 – 2002	B.S. in Physics Program, Université Libre de Bruxelles, Brussels, Belgium. Thesis Title: <i>NMR Studies of Molecular Dynamics in Fullerene Crystals</i> . Graduation Date: June 2002 - Grande Distinction (High Honors)
1998 – 2000	Civil Engineer Candidate Program, Université Libre de Bruxelles, Belgium. Graduation Date: September 2000

Research Experience

▶ 2010 – now	Position: Research Staff Member
	Employer: International Business Machines (IBM), Yorktown Heights, New York, USA.
	Department: Research & Development at the T. J. Watson Research Center
	Team leader: Vijay Narayanan

Research Areas

- High-K metal gate stacks
- Oxide/Si interfaces
- Alternate dielectrics
- Impact of thermal budget on CMOS

Responsibilities

- Develop low & high-T flow alternate dielectric formation processes for quality CMOS fabrication
- Design and implementation of device fabrication processes for the on-site production line
- Take active part in new tool integration
- Write progress assessments and represent group

Achievements

- **Silicate formation:** successful tuning of device properties (voltage, leakage, etc...) and increased gate scaling achieved by [REDACTED]
- **Zero Interface Layer:** [REDACTED] suppress the SiO₂ layer and increase the effective dielectric constant of the gate stack.
- **Tool integration:** collaboration with on-site vendor technicians to optimize a new 30 mm wafer production line deposition process.
- **Patent:** gate scaling and voltage control in Si CMOS devices [REDACTED] (submitted).

► 2009 – 2010 Position: Collaborating Researcher

Employer: [Central Research Institute of Electric Power Industry \(CRIEPI\)](#), Yokosuka, JP.

Department: Materials Science Research Laboratory

Team leader: [Hidekazu Tsuchida](#)

Research Areas

- Metal/SiC and Oxide/SiC interfaces
- Impact of thermal oxidation on the SiC substrate
- Deposited oxides on SiC
- Novel methods to improve SiC device quality and reliability

Responsibilities

- Establish SiC interface research at the Institute (including device fabrication, characterization and implementation of experimental setups)
- Initiate collaborations
- Write reports
- Represent group at meetings and conferences

Achievements

- **Device fabrication:** [REDACTED]
- **SiC surface states:** [REDACTED]
- **Deposited oxides:** optimized a new technique [REDACTED]
- **Patent:** passivation method to enhance the interface in SiC devices [REDACTED] (submitted).

Implemented Setups

- **CV measurements:** High and low frequency Capacitance-Voltage MOS setup was developed, including the implementation of the acquisition and analysis software.
- **SBD characterization:** Automated routines were written to extract SBD properties from both Current-Voltage curves in forward bias and Capacitance-Voltage curves in reverse bias.

► **2008 – 2009** Position: **Research Associate (Post-Doc)**
&

► **2005 – 2008** Position: **Research Assistant**

Employer: [Vanderbilt University](#), Nashville TN, USA.

Departments: [Institute of Nanoscale Science and Engineering](#) &
[Department of Physics and Astronomy](#)

PI & Advisor: [Leonard C. Feldman](#)

Ph.D. Thesis Title: [Electronic Properties and Reliability of the SiO₂/SiC Interface](#)

Research Areas

- Oxide/semiconductor interface quality and reliability in SiC MOS devices
- Oxide growth and passivation techniques for enhanced performances of SiC MOSFETs
- Oxidation kinetics of semiconductors at high temperature and high pressure

Responsibilities

- Device fabrication, characterization and experimental setup implementation
- Writing articles, reports and proposals
- Interaction with funding agencies
- Coordination of joint research projects
- Participation to meetings and conferences
- Supervision of junior researchers
- Management of research facilities

Achievements

- **Impact of NO on reliability:** carrier injection techniques (X-ray irradiation, Fowler-Nordheim tunneling and photoemission) were used to establish the impact of N at the SiO₂/SiC interface on reliability.
- **Scaling of properties with N content:** mobility and interface state density were correlated with N at the SiO₂/SiC interface in MOS devices using SIMS, accelerated injection techniques, CV and IV.
- **Device failure:** using TDDB, the MTTF of SiC MOS devices was linked to the voltage instabilities induced by charge trapping and to the surface roughness of SiC.
- **Oxygen partial pressure:** high pressure oxidation allowed to decouple the impact of growth rate and temperature on the properties of SiC oxides, yielding a better understanding of the role of Na in MEO.
- **The SiC bulk:** to probe the effect of oxidation and passivation on the SiC side of the MOS interface, techniques such as e⁺ irradiation, EPR of Si¹³C/ Si¹²C bilayers, and RBS were used.
- **Others:** study of interface properties on alternate SiC polytypes, NBTI measurements, etc...

Implemented Setups (*entirely designed and built*)

- **Oxidation station:** MOS device grade setup for the formation of gate oxides at high temperatures and the subsequent annealing in gases such as NO, HCl, etc...
- **High pressure oxidation:** MOS device grade setup that operates at pressures up to 4 atm to accelerate gate oxide formation at a given temperature.
- **Photo-injection setup:** to perform accelerated testing at low gate oxide fields, the focused radiation of a mercury lamp is redirected to MOS devices having semi-transparent gate metals using UV optics.
- **TDDB setup:** a probe station fits a 36-probe card connected to devices on a designed heat controlled chuck. While bias is applied, a switch matrix and a voltmeter allow to continuously check for failure. A custom **LabView program** was written to remotely control the units and perform data analysis.
- **Automated CV:** coupling of CV and I-t measurements (e.g, for NBTI). A custom **LabView program** remotely controls and monitors testing of several devices in parallel during charge injection.

► **2003 – 2005 Position: Research Assistant**

Employer: [Vanderbilt University](#), Nashville TN, USA.

Department: [Institute of Nanoscale Science and Engineering](#).

Advisors: [Leonard C. Feldman](#) and [Richard F. Haglund, Jr.](#)

M.S. Thesis Title: [Properties of Nanocrystalline Vanadium Dioxide](#).

Research Areas

- Study of electrical and optical properties of VO₂ thin films and nanoparticles
- VO₂ based devices (FETs, ROMs...)

Responsibilities

- Conduct research and implement setups
- Write journal articles and technical reports
- Participate to the writing of proposals
- Present work at conferences and meetings

Achievements

- **VO₂ synthesis:** nanoparticles and thin films were synthesized using pulsed laser deposition.
- **Percolation:** networks of VO₂ nanoparticles yielded percolation paths, explaining the different threshold temperatures observed optically and electrically for the onset of the metal-semiconductor transition.

Implemented Code and Setup

- **Simultaneous optical and electrical probe:** an infrared laser, a voltmeter, and a vacuum chamber are used with a **LabView program** to monitor optical and electrical properties of thin films vs. temperature.
- **C++ code:** a program was written to run on a supercomputer using MPI. It allows to simulate current percolation in large 2D lattices.

Other projects

- **Simulation of a high performance 35nm gate CMOS:** effects of halo doping and super steep steep retrograde profiles on short channel effects were investigated and compared with experimental results.

► **2001 – 2003 B.S. / M.S. Student**

School: [Université Libre de Bruxelles](#), Solid State Physics, Brussels, Belgium

Department : [Condensed Matter and Nuclear Magnetic Resonance](#)

Advisor: [Francis Masin](#)

B.S. Thesis Title: [NMR Studies of Molecular Dynamics in Fullerene Crystals](#).

Research Areas

- Solid State NMR
- Molecular dynamics in crystals
- Computer simulation of van der Waals solid dynamics

Responsibilities

- Conduct experimental research
- Link findings to solid state physics
- Write journal articles
- Present work at conferences and meetings

Achievements

- **C₆₀ crystal dynamics:** using temperature-dependent nuclear magnetic resonance, the dynamics of molecules in a fullerene-ferrocene van der Waals solid were identified.

Implemented Code

- **Molecular dynamics simulations:** complex custom **C++** code to calculate activation energies and rotation barriers in a C₆₀ molecular solid using X-ray data and interaction potentials.

Collaborations

- Auburn Univ.** Performed some of the Ph.D. Thesis and Post-Doc work in **Prof. Williams'** labs.
- Leuven Univ.** Located in Belgium, measured reliability of SiC devices with **Prof. Afanas'ev**.
- General Electrics** Investigated isotopically enriched SiC from **Dr. Fronheiser** and **Dr. Matocha**.
- Simon Fraser Univ.** Furnished SiC devices for DLTS characterization by **Prof. Mooney**.
- Washington State Univ.** Positron studies of bulk SiC defects induced by oxidation with **Prof. Lynn**.
- Univ. of Alabama, Birm.** Electron Spin Resonance of SiC substrates with **Prof. Zvanut**.
- Univ. of Tulsa** Suggested oxide/SiC defects to **Prof. Wang** for theoretical DFT analysis.
- Univ. of North Carolina** Growth of thin films for opto-electronics with **Prof. Lopez**.
- Etc...*

Teaching Experience

- 2006 – 2007 **Mentoring** of Senior Undergraduate Student in Physics, Pursuing Honor Thesis, Vanderbilt University, Nashville TN, USA. (Resulted in High Honors and a Publication)
- 2002 – 2003 **High School Physics Teacher**, Institut Universalis, Brussels, Belgium.
- 2001 – 2002 **Teaching Assistant**, Physics Laboratories, Université Libre de Bruxelles, Brussels, Belgium.

Other Professional Activities

- Current* **Reviewer** for IEEE (Electron Device Letters), for the American Institute of Physics (Applied Physics Letters, Journal of Applied Physics), for the American Physical Society (Physical Review B) and for the Materials Research Society.
- Summer 1996* **Network Technician**, Queen's University, Belfast, Northern Ireland, UK.

Technical Skills

Device Fabrication

- High temperature oxidation
- Chemical etching
- Chemical conditioning
- Thermal evaporation
- DC/RF sputtering
- Photolithography
- PLD (pulsed laser deposition)
- CVD (chemical vapor deposition)
- PVD (physical vapor deposition)
- ALD (atomic layer deposition)
- Implant / activation
- RTA (rapid thermal annealing)
- ...

Characterization

- CV (capacitance-voltage)
- DLTS (deep level transient spectroscopy)
- IV (current-voltage)
- Charge Injection (optical & electrical)
- TDDB (dielectric time to breakdown)
- Ellipsometry
- RBS (Rutherford backscattering)
- XRD (X-ray diffraction)
- SEM/TEM Electron Microscopy
- AFM (atomic force microscopy)
- Hall effect
- Photoluminescence and carrier lifetime
- NMR (nuclear magnetic resonance)

Computing Skills

Programming

- C++
- MPI (parallel programming)
- Taurus (Synopsis, device modeling)
- LabView
- HTML
- Mathematica
- LaTeX
- Agilent EasyExpert

Applications and OS

- MS Office
- Igor Pro
- Origin
- Image processing softwares
- Linux
- Windows
- ...

Languages

- English** Proficient (written and spoken).
- French** Proficient (written and spoken). Native Language.
- Dutch** Intermediate. Second National Language.
- Japanese** Beginner. Learning.

List of References.....

- **Prof. Leonard C. Feldman**, *Stevenson Professor of Physics*, Department of Physics and Astronomy, and Institute of Nanoscale Science and Engineering , Vanderbilt University, Nashville TN, USA. E-mail: leonard.c.feldman@vanderbilt.edu
- **Dr. Hidekazu Tsuchida**, Materials Science Research Laboratory, Central Research Institute of the Electric Power Industry, Yokosuka Kanagawa, Japan. E-mail: tsuchida@criepi.denken.or.jp
- **Prof. Sokrates T. Pantelides**, *Williams and Nancy McMinn Professor of Physics*, Department of Physics and Astronomy, Vanderbilt University, Nashville TN, USA. E-mail: pantelides@vanderbilt.edu
- **Prof. Valeri V. Afanas'ev**, Department of Physics and Astronomy, Katholieke Universiteit Leuven, Leuven, Belgium. E-mail: valeri.afanasiev@fys.kuleuven.be
- **Prof. Dan M. Fleetwood**, Department of Electrical Engineering and Computer Science, Vanderbilt University, Nashville TN, USA. E-mail: dan.fleetwood@vanderbilt.edu
- **Prof. Ronald D. Schrimpf**, *Orrin Henry Ingram Professor of Engineering*, Department of Electrical Engineering and Computer Science, Vanderbilt University, and Institute for Space and Defense Electronics, Nashville TN, USA. E-mail: ron.schrimpf@vanderbilt.edu

Selected Talks

- **INVITED – Charge trapping at nitrated SiO₂/SiC interfaces.** **J. Rozen**, J. R. Williams and L. C. Feldman, [2009 Japanese SiC Conference](#) (Kobe, Japan).
- *The limits of post oxidation annealing in NO.* **J. Rozen**, X. Zhu, A. C. Ahyi, J. R. Williams and L. C. Feldman, [2009 ICSCRM](#) International Conference on Silicon Carbide and Related Materials (Nuremberg, Germany).
- *Scaling between nitrogen content and carrier trap densities at the SiO₂/SiC interface.* **J. Rozen**, J. R. Williams and L. C. Feldman, [2008 IEEE SISC](#) Semiconductor Interface Specialists Conference (San Diego CA, USA).
- *Suppressed electron-induced interface state generation and enhanced hole trapping in nitrated gate oxides on n-type 4H-SiC.* **J. Rozen**, S. Dhar, S. Wang, S. T. Pantelides, V. V. Afanas'ev, J. R. Williams and L. C. Feldman, [2007 ICSCRM](#) International Conference on Silicon Carbide and Related Materials (Otsu, Japan).
- *Impact of nitridation on negative and positive charge buildup in SiC gate oxides.* **J. Rozen**, S. Dhar, J. R. Williams, and L. C. Feldman, [2007 ISDRS](#) International Semiconductor Device Research Symposium (College Park MD, USA)
- *Percolation effects in networks of vanadium dioxide nanocrystals.* **J. Rozen**, R. Lopez, R. F. Haglund, Jr. and L. C. Feldman, [2006 APS March Meeting](#) of the American Physical Society (Baltimore MD, USA).

Publications

- *Scaling between channel mobility and interface state density in SiC MOSFETs.* **J. Rozen**, A. C. Ahyi, X. Zhu, J. R. Williams and L. C. Feldman (redacted)
- *Capacitance-voltage and deep level-transient spectroscopy characterization of defects near SiO₂/SiC interfaces.* A. F. Basile, **J. Rozen**, J. R. Williams, L. C. Feldman and P. M. Mooney, *J. Appl. Phys.* (in press).
- *The effect of nitrogen plasma anneals on interface trap density and channel mobility for 4H-SiC MOS devices.* X. Zhu, A. C. Ahyi, M. Li, Z. Chen, **J. Rozen**, L. C. Feldman and J. R. Williams, *Solid State Electron.* **57**, 76 (2011).
- *Passivation of deep levels at the SiO₂/SiC interface.* A. F. Basile, **J. Rozen**, X. D. Chen, S. Dhar, J. R. Williams, L. C. Feldman and P. M. Mooney, *ECS Trans.* **28**, 95 (2010).
- *The limits of post-oxidation annealing in NO.* **J. Rozen**, X. Zhu, A. C. Ahyi, J. R. Williams and L. C. Feldman, *Mater. Sci. Forums* **645-648**, 693 (2010).
- *Effect of NO annealing on 6H- and 4H-SiC MOS interface states.* A. F. Basile, **J. Rozen**, X. D. Chen, S. Dhar, J. R. Williams, L. C. Feldman and P. M. Mooney, *Mater. Sci. Forums* **645-648**, 499 (2010).
- *Charge trapping properties of 3C- and 4H-SiC MOS capacitors with nitrided gate oxides.* R. Arora, **J. Rozen**, D. M. Fleetwood, K. F. Galloway, C. X. Zhang, J. Han, S. Dimitrijević, F. Kong, L. C. Feldman, S. T. Pantelides and R. D. Schrimpf, *IEEE Trans. Nucl. Sci.* **56** (6), 3185 (2009).
- *Density of interface states, electron traps, and hole traps as a function of the nitrogen density in SiO₂ on SiC.* **J. Rozen**, S. Dhar, M. E. Zvanut, J. R. Williams and L. C. Feldman, *J. Appl. Phys.* **105**, 124506 (2009).
- *Impact of nitridation on negative and positive charge buildup in SiC gate oxides.* **J. Rozen**, S. Dhar, S. Wang, V. V. Afanas'ev, S. T. Pantelides, J. R. Williams and L. C. Feldman, *Mater. Sci. Forums* **600-603**, 803 (2009)
- *Increase in oxide hole trap density associated with nitrogen incorporation at the SiO₂/SiC interface.* **J. Rozen**, S. Dhar, S. K. Dixit, F. O. Roberts, H. L. Dang, S. Wang, V. V. Afanas'ev, S. T. Pantelides, J. R. Williams and L. C. Feldman, *J. Appl. Phys.* **103**, 124513 (2008).
- *Pressure dependence of SiO₂ growth kinetics and electrical properties on SiC.* E. A. Ray, **J. Rozen**, S. Dhar, J. R. Williams and L. C. Feldman, *J. Appl. Phys.* **103**, 023522 (2008) – Corresponding Author.
- *Suppression of interface state generation upon electron injection in nitrided oxides grown on 4H-SiC.* **J. Rozen**, S. Dhar, S. Wang, V. V. Afanas'ev, S. T. Pantelides, J. R. Williams and L. C. Feldman, *Appl. Phys. Lett.* **91**, 153503 (2007). *Selection of the Virtual Journal of Nanoscale Science & Technology* volume 16, issue 17 (2007).
- *Total dose radiation response of nitrided and non-nitrided SiO₂/4H-SiC MOS capacitors.* S. K. Dixit, S. Dhar, **J. Rozen**, S. Wang, R. D. Schrimpf, D. M. Fleetwood, S. T. Pantelides, J. R. Williams and L. C. Feldman, *IEEE Trans. Nucl. Sci.* **53** (6), 3687 (2006).
- *Two-dimensional current percolation in nanocrystalline vanadium dioxide films.* **J. Rozen**, R. Lopez, R. F. Haglund and L. C. Feldman, *Appl. Phys. Lett.* **88** (8), 081902 (2006).
- *Dynamical model for the C₅H₅ cycles in the C₆₀ · 2 Fe(C₅H₅)₂ solvate.* **J. Rozen**, R. Céolin H. Szwarc and F. Masin, *Phys. Rev. B* **70**, 144206 (2004).
- *Solid State ¹³C and ¹H NMR Investigations on C₆₀ · 2 ferrocene.* **J. Rozen**, R. Céolin J. L. Tamarit, H. Szwarc and F. Masin, Proceedings of the XVII International Winterschool Euroconference on Electronic Properties of Novel Materials (Kirchberg, Austria), *AIP Conf. Proc.* **685**, 19 (2003).
- *Other conference proceedings...*