

Arup Polley
(aruppolley@iisc.ac.in)

EDUCATION

Doctor of Philosophy, December 2008

Electrical and Computer Engineering
Georgia Institute of Technology, Atlanta, GA
Title: High Performance Multimode Fiber Systems: A Comprehensive Approach
Advisor: Prof. Stephen E. Ralph
GPA: 3.81/4.00

Master of Science, May 2008

Physics
Georgia Institute of Technology, Atlanta, GA

Master of Science, May 2005

Electrical and Computer Engineering
Georgia Institute of Technology, Atlanta, GA

Bachelor of Technology, June 2003

Electronics and Electrical Communication Engineering
Indian Institute of Technology, Kharagpur, India
GPA: 9.44/10.00

Graduate Non-degree Course

Quantum Field Theory, 2016, Mathematics, University of Texas at Dallas, TX

RESEARCH INTERESTS

- Analog and mixed-signal IC design
- Integrated Silicon Photonics
- Sensor physics
- Sensing and opto-electronic applications of 2D materials
- Physics and electronic transport in 2D materials

HONOURS & OTHER RECOGNITIONS

- *IEEE senior member* since 2018
- *Member Group Technical Staff (MGTS)* at Texas Instruments Inc. (TI)
- *Associate Editor* for Journal of Computational Electronics (JCEL), Springer
- *Technical liaison* for TI in Nano-electronics Research Initiative (NRI) program of Semiconductor Research Corporation (SRC) for university research funding
- Finalist in the *Corning Outstanding Student Paper* in Optical Fiber Communication Conference (OFC) in 2008.
- *Jagadish Bose National Science Talent Search (JBNSTS)* Scholarship – Awarded to only 15 students all over India in 2000.
- *National Talent Search* Scholarship – Awarded to only 750 students all over India in 1997.

TEACHING EXPERIENCE

University of Texas at Dallas, Department of Bioengineering, Dallas, TX

- Lecture: Intermediate Electrical Systems (BMEN4320), Fall 2018.

Indian Institute of Science, Bangalore

- Lecture: Analog VLSI circuits (E3 238), Fall 2021.
- Lecture: Analog Electronics and Industrial Instrumentation (E3 203) Spring 2022

RESEARCH EXPERIENCE

Associate Professor (April 2021 –)

Indian Institute of Science, Bangalore, Department of Electronic Systems Engineering.

Faculty in the field of Mixed signal IC design, silicon photonics, nano-electronics and quantum sensing. Leading Photonic and Nano-electronic Integrated Circuits and Systems (PhNEICS) laboratory.

Senior Research Scientist (March 2013 – March 2021)

Kilby Research Laboratories, Texas Instruments Inc.

Leading advanced R&D in sensors and signal path.

- Developed CMOS Hall sensor with best-in-class performance in gain accuracy, offset stability and bandwidth. The key innovations include the use of octagonal Hall plate for improved offset stability, multipath signal chain architecture for high bandwidth, and active gain calibration [US patents 15, 16, 17, 18, 20]. The design concepts are at the core of TI's differential Hall sensor-based current sensor product family.
- Led research in magnetic field based, non-contact, current sensing product development. Innovated techniques to remove higher-order external magnetic field interference [US patents 13, 14, 18].
- Developed ultra-low power PhotoPlethysmoGraph (PPG) signal chain for wearable devices that exploits adaptive power-SNR trade-off using signal statistics [Journal 6, US Patents 5, 6, 7, 8, 9, 10]. The design concepts are incorporated in TI product "ultra-small integrated AFE for wearable optical heart-Rate monitoring and biosensing" (<http://www.ti.com/product/AFE4410>).

Adjunct Faculty (Sept. 2017 – Present)

Erik Jonsson School of Engineering and Computer Science, University of Texas at Dallas

Leading TI's exploratory university research programs on graphene technology and devices. Since 2015, collaborating with the research group of Prof. Jiyoung Kim at Materials Science & Engineering at University of Texas at Dallas (UTD).

- Invented a novel *ambipolar* gate modulation technique exploiting unique band-structure of graphene to mitigate low frequency flicker noise and offset of graphene-based Hall-effect sensor [US patents 1, 2]. Demonstrated proof-of-concept device with fabrication support from UTD [conf. 19].
- Developing process integration & device fabrication of graphene-based devices in CMOS process platform [US patent 3].

- Exploring theoretically the effects of flexural phonons on electronic transport in 2D materials [Journal 1]

Analog & Mixed Signal Design Engineer (Jan. 2009 – Feb. 2013)

Storage Products Group, R & D division, Texas Instruments Inc.

Developed signal path for the *touch-down* and *fly-height* sensors in custom preamplifier chip for magnetic hard disk drive industry. Accurate detection of *touch-down* and *fly-height* is essential for the scaling of spatial density of magnetic storage (bits per sq. in.)

- Architected & designed a patented signal chain that uses temperature coefficient of resistor to detect *touch-down* of recording head on media. The signal chain became part of custom preamplifier product family for Western Digital earning revenue of \$160M (up to 2015) and received TI's *Patent Incentive Reward* in 2016 [US patent 23].
- Architected & designed a patented signal chain that uses triboelectric current from head to media to estimate accurate *fly-height*. The signal chain uses a novel high-accuracy, bias-compensated MOS resistor for low area implementation [Journal 4, US patents 21, 22].

Graduate Research Assistant (Aug. 2003 – Dec. 2008)

Ultrafast Optics Laboratory, Georgia Institute of Technology

- Developed technologies for alignment tolerant, high-bandwidth plastic optical fiber (POF) links for short-reach network. Demonstrated that strong mode-coupling helps bandwidth enhancement in POF. Developed high-speed receiver for large-area photodiode improving alignment tolerance at the receiver [Journal 8].
- Designed opto-electronic chromatic dispersion compensator for single mode fiber [conf. 10].
- Demonstrated Raman amplification as a method of reducing inter-symbol interference in multimode fiber [Journal 9].
- Developed a quantitatively accurate hydrodynamic model for photoconductive Terahertz emitter [conf. 14].

Under-Graduate Student Researcher (May. 2002 – July. 2002)

Ultrafast Optics Laboratory, Georgia Institute of Technology

- Developed a model for multimode optical fiber using WKB method [conf. 18].

JOURNAL PUBLICATIONS

1. **A. Polley**, A. V. Ravichandran, V. Kumar, A. Venugopal, L. Cheng, A. Lucero, J. Kim, Lu. Colombo, R. R. Doering, "Ambipolar Gate Modulation Technique for the Reduction of Offset and Flicker Noise in Graphene Hall-effect Sensor," *IEEE Sensors Journal*, vol. 21, no. 22, pp. 25675-25686, 15 Nov.15, 2021.
2. **A. Polley**, S. M. Ramaswamy, B. H. Haroun, "Residual Offset in Silicon Hall-Effect Sensor: Analytical Formula, Stress Effects, and Implications for Octagonal Hall Plate Geometry," *IEEE Sensors Journal*, vol. 20, no. 19, pp. 11283-11291, October 2020.
3. M. V. Fischetti, and **A. Polley**, "Superconductivity induced by flexural modes in non- σ_h -symmetric Dirac-like two-dimensional materials: A theoretical study for silicene and germanene," *Phys. Rev. B* 97, 144509, 12 April 2018.

4. **A. Polley**, P. Pandey, B. E. Bloodworth, C. Cazana, "Analog Frontend for Tribo-Current-based Fly-Height Sensor for Magnetic Hard Disk Drive," *IEEE Transaction on Circuits and Systems-I*, vol. 65, no. 2, Feb. 2018.
5. A. V. Ravichandran, J. Lee, L. Cheng, A. T. Lucero, C. D. Young, L. Colombo, A. Venugopal, **A. Polley**, J. Kim, "Wafer Scale Graphene Field Effect Transistors on Thin Thermal Oxide," *ECS Transactions*, vol. 86, no. 2, pp. 51-7, 2018.
6. A. Sharma, **A. Polley**, S. B Lee, S. Narayanan, W. Li, T. Sculley, S. Ramaswamy, "A Sub-60- μ A Multimodal Smart Biosensing SoC With >80-dB SNR, 35- μ A Photoplethysmography Signal Chain," *IEEE Journal of Solid-State Circuits*, vol. 52, no. 4, April 2017.
7. P. J. Decker, **A. Polley**, J. H. Kim and S. E. Ralph, "Statistical Study of Graded-Index Perfluorinated Plastic Optical Fiber," *Journal of Lightwave Technology*, v 29, n 3, February 2011, p 305-315.
8. **A. Polley** and S. E. Ralph, "Mode coupling plastic optical fiber enables 40Gbps performance," *IEEE Photonics Technology Letters*, vol. 19, pp. 1254-1256, August 2007.
9. **A. Polley** and S. E. Ralph, "Raman amplification in multimode fiber," *IEEE Photonics Technology Letters*, vol. 19, pp. 218-220, Feb. 2007.
10. K. Balemarthy, **A. Polley** and S. E. Ralph, "Electronic equalization of multikilometer 10-Gb/s multimode fiber links: mode-coupling effects," *Journal of Lightwave Technology*, v 24, n 12, Dec. 2006, p 4885-94.
11. K. M. Patel, **A. Polley**, K. Balemarthy and S. E. Ralph, "Spatially resolved detection and equalization of modal dispersion limited multimode fiber links," *Journal of Lightwave Technology*, v 24, n 7, July 2006, p 2629-36.
12. J. H. Kim, **A. Polley** and S. E. Ralph, "Efficient photoconductive terahertz source using line excitation," *Optics Letters*, v 30, n 18, Sept. 2005, p 2490-2.

PEER-REVIEWED CONFERENCE PAPERS

1. A. Ravichandran, L. Cheng, A. T. Lucero, J. Lee, J. S. Lee, A. Venugopal, **A. Polley**, L. Colombo, J. Kim, "High performance graphene field effect transistor fabrication using alternative metal etching route," TMS 2018, Phoenix, AZ, Mar 12, 2018.
2. A. Ravichandran, J. Lee, L. Cheng, A. T. Lucero, C. D. Young, L. Colombo, A. Venugopal, **A. Polley**, J. Kim, "Wafer scale graphene field effect transistors on thin thermal oxide," AiMES 2018 ECS and SMEQ Joint International Meeting, Cancun, Mexico, Oct 2, 2018.
3. A. Sharma, S. B Lee, **A. Polley**, S. Narayanan, W. Li, T. Sculley, S. Ramaswamy, "Multi-modal Smart Bio-sensing SoC Platform with >80dB SNR 35 μ A PPG RX Chain," 2016 Symposium on VLSI Circuits Digest of Technical Papers, 2016.
4. **A. Polley**, C. Chen, K. D. Choquette and S. E. Ralph, "Highly alignment tolerant 10Gb/s links using very large core plastic optical fiber," 2009 Conference on Lasers and Electro-Optics (CLEO), 2009, CMC4.
5. **A. Polley**, P. J. Decker, J. H. Kim and S. E. Ralph, "Plastic Optical Fiber Links: A Statistical Study," Optical Fiber Communication Conference (OFC), 2009, OMS3.
6. **A. Polley**, P. J. Decker and S. E. Ralph, "10 Gb/s, 850nm VCSEL-POF links," 2008 Conference on Lasers and Electro-Optics (CLEO), 2008, CTuLL3.
7. **A. Polley** and S. E. Ralph, "100 m, 40 Gb/s Plastic Optical Fiber Link," Optical Fiber Communication Conference (OFC), 2008.
8. **A. Polley**, K. Balemarthy and S. E. Ralph, "Mode coupling: Why POF supports 40Gbps," 2007 Conference on Lasers and Electro-Optics (CLEO), 2007, CWM5.
9. **A. Polley**, R. J. Gandhi and S. E. Ralph, "40 Gbps short reach links using plastic

- optical fiber,” Optical Fiber Communication Conference (OFC), 2007, OMR5.
10. **A. Polley** and S. E. Ralph, “Receiver-side, adaptive, opto-electronic chromatic dispersion compensation of single-mode fiber,” Optical Fiber Communication Conference (OFC) 2007, JThA51.
 11. R. J. Gandhi and **A. Polley**, “40 Gb/s short reach links using plastic optical fiber,” The 19th Annual Meeting of the IEEE Lasers and Electro-Optics Society (LEOS) 2006, WX3.
 12. **A. Polley** and S. E. Ralph, “Raman amplification in multi mode fiber: Reduction of inter-symbol interference via mode selective gain,” The 19th Annual Meeting of the IEEE Lasers and Electro-Optics Society (LEOS) 2006, WX6.
 13. **A. Polley** and S. E. Ralph, “Raman Amplification in Multi-Mode Fiber: Reduction of Inter-Symbol Interference via Mode Selective Gain,” 2006 Optical Amplifiers and their Applications (OAA) Topical Meeting, paper, 2006, OWC2.
 14. **A. Polley**, J. H. Kim and S. E. Ralph, “Efficient photoconductive THz source with spatially shaped excitation” 2005 Conference on Lasers and Electro-Optics (CLEO) , v 3, 2005, p 1942-4, TuX3.
 15. J. H. Kim, **A. Polley** and S. E. Ralph, “High efficiency terahertz photoconducting sources by use of spatially shaped excitation,” The 17th Annual Meeting of the IEEE Lasers and Electro-Optics Society (LEOS) 2004, v 1, Nov. 2004, p 374-5.
 16. S. E. Ralph, Z. Zhiyong, D. Mattox, K. M. Patel, K. B. Wise and **A. Polley**, “Optimizing the third-order optical susceptibility of Pt-doped BaTiO₃ grown by combustion chemical vapor deposition,” 2004 Conference on Lasers and Electro-Optics(CLEO), v 1, May 2004, p 1132-3.
 17. K. M. Patel, **A. Polley** and S. E. Ralph, “Modal dispersion compensation by simultaneous use of spatially resolved equalization and restricted mode launch,” The 16th Annual Meeting of the IEEE Lasers and Electro-Optics Society (LEOS) 2003, ThX4.
 18. S. E. Ralph, K. M. Patel, C. Argon, **A. Polley** and S. W. McLaughlin, “Intelligent receivers for multimode fiber: optical and electronic equalization of differential modal delay,” The 15th Annual Meeting of the IEEE Lasers and Electro-Optics Society (LEOS), v 1, Nov. 2002, p 295-6.

INVITED CONFERENCE PRESENTATIONS

19. **A. Polley**, A. V. Ravichandran, V. Kumar, A. Venugopal, L. Cheng, A. Lucero, J. Kim, Lu. Colombo, R. R. Doering, “Ambipolar Electronics using Graphene,” Graphene 2018, Dresden, Germany.
20. S. E. Ralph and **A. Polley**, “40-Gb/s in Plastic Optical Fiber,” Optical Fiber Conference (OFC) 2008.

TEXAS INSTRUMENTS TECHNICAL CONFERENCES

1. **A. Polley**, S. M. Ramaswamy, B. Haroun, D. Garcia, K. Green, D. Trifonov, T. Larson, “1MHz bandwidth, 50 μ T offset, 0.1% gain accurate Hall-effect magnetic field sensor for non-contact current sensing application,” *2019 TI Technical Leadership Conference*.
2. **A. Polley**, P. Pandey, B. Bloodworth, C. Cazana, “Analog Frontend for Tribo-Current-based Fly-Height Sensor for Magnetic Hard Disk Drive,” *2017 TI Technical Leadership Conference*.

3. S. B. Lee, A. Sharma, **A. Polley**, W. Li, T. Sculley, S. Ramaswamy, "A 1.3 μ W 14bit 1kS/s SAR ADC in 130nm CMOS with a Reduced Sized Calibration DAC for SoC Applications," *TI Technical Journal*, vol. 2, no. 1, August 2016.

PATENTS

(Granted: 22, used in products: 8)

Graphene Devices and Integration

1. **A. Polley**, A. Venugopal, L. Colombo, R. R. Doering, "Low offset Graphene Hall sensor," U. S. Patent: 10,001,529B2, grant date June 19, 2018.
2. **A. Polley**, A. Venugopal, L. Colombo, R. R. Doering, "Low noise Graphene Hall sensors, systems and methods of making and using same," U.S. Patent: 10,069,065, grant date September 04, 2018.
3. A. Venugopal, **A. Polley**, L. Colombo, "Integration of Graphene and Boron Nitride hetero-structure device over semiconductor layer," U. S. Patent: 10,304,967, grant date May 28, 2019.
4. B. Haroun, **A. Polley**, S. Ramaswamy, "Amplification using ambipolar Hall effect in graphene," US patent: 20200182950, publication date June 11, 2020.

Low-power & Smart Sensing Systems & PhotoPlethysmography

5. **A. Polley**, A. Sharma, S. M. Ramaswamy, S. Narayanan, "Transmitter architecture for photoplethysmography systems," U.S. Patent: 10,187,940, grant date January 22, 2019.
6. **A. Polley**, A. Sharma, S. B. Lee, S. Narayanan, S. M. Ramaswamy, "Methods and Apparatus for Reducing Noise, Power and Settling Time in Multi-Modal Analog Multiplexed Data Acquisition Systems," U.S. Patent: 9,667,289, grant date May 30, 2017.
7. S. Narayanan, S. M. Ramaswamy, **A. Polley**, A. Sharma, "Exploiting Constructive Interference from Ambient Conditions," U.S. Patent: 9,615,427B1, grant date April. 4, 2017.
8. S. Narayanan, S. M. Ramaswamy, **A. Polley**, A. Sharma, "Sensor with low power model based feature extractor," U.S. Patent: 9,397,685 B1, grant date July. 19, 2016.
9. A. Sharma, S. M. Ramaswamy, S. Narayanan, **A. Polley**, S. B. Lee, W. Li, "Optical receiver chain for components of a photoplethysmograph signal," U.S. Patent: 9,717,426, grant date August 1, 2017.
10. S. Narayanan, S. M. Ramaswamy, A. Sharma, **A. Polley**, "Baseline compensation system," US Patent: 9,742,420B2, grant date August 22, 2017.
11. A. Sharma, S. B. Lee, S. M. Ramaswamy, S. Narayanan, **A. Polley**, "Calibrated SAR ADC having a reduced size," U.S. Patent: 9,319,059 B1, grant date April. 4, 2016.
12. A. Sharma, S. B. Lee, S. M. Ramaswamy, S. Narayanan, **A. Polley**, "Dual comparator-based error correction scheme for analog-to-digital converters," U.S. Patent: 9,148,159 B1, grant date Sept. 17, 2015.

Magnetic Sensing & Current Sensing Systems

13. **A. Polley**, R. M. Rosenquist, T. L. Sculley, "Removal of higher order magnetic interference in magnetic field based current sensors," U. S. Patent: 10,082,527, grant date Sept. 25, 2018.
14. **A. Polley**, S. M. Ramaswamy, T. L. Sculley, "Fluxgate-based Current Sensor," U. S. Patent: 9,778,288B2, grant date October 03, 2017.

15. **A. Polley**, R. M. Rosenquist, T. L. Sculley, "Closed-Loop Device Calibration Using a Wideband Signal," U. S. Patent: 9,810,759B2, grant date November 07, 2017.
16. G. Thiagarajan, **A. Polley**, T. L. Sculley, "Methods and apparatus for magnetic sensor with integrated calibration mechanism," U. S. Patent: 9,778,327B2, grant date October 3, 2017.
17. **A. Polley**, S. M. Ramaswamy, B. S. Haroun, R. Mukhopadhyay, "High bandwidth Hall sensor," US patent: 10,197,638, grant date Feb 5, 2019.
18. **A. Polley**, S. M. Ramaswamy, B. S. Haroun, R. Mukhopadhyay, "Transimpedance amplifier-based reduction of Hall sensor parasitic impedance," US patent: 10,041,811B2, grant date August 07, 2018.
19. **A. Polley**, S. M. Ramaswamy, B. S. Haroun, "Magnetic field-based current measurement," US patent: 10598700, grant date March 24, 2020.
20. **A. Polley**, S. M. Ramaswamy, B. S. Haroun, "Calibration of Hall device sensitivity using an auxiliary Hall device," US patent: 10698066, grant date June 30, 2020.

Sensing Systems in magnetic Hard-Disk-Drive

21. **A. Polley**, P. Pandey, B. Bloodworth, "Analog front end for proximity sensing of tunneling current," U.S. Patent: 8896950 B1, grant date Nov. 25, 2014.
22. **A. Polley**, "MOS resistor apparatus and methods," U.S. Patent: 8710904, grant date April 29, 2014.
23. **A. Polley**, R. Mukhopadhyay, R. Sharifi, M. A. Wolfe, "Proximity Sensing System," U.S. Patent: 8 369 190 B2, grant date Feb. 5, 2013.