Pulugurtha Markondeya Raj

- Associate Professor, Biomedical Engineering, Florida International University
- Associate Professor, Electrical and Computer Engineering, Florida International University

Major Research Areas: Packaging of bioelectronic and electronic systems, heterogeneous system integration, passive components, power and data telemetry, flex and 3D packaging, Hermetic packaging, interconnects and connectors

Application focus: Wireless sensors, Neural Recording and stimulation, Photonic biosensors, Power modules,

Degree	Month, Year	University	Field
Ph.D	June, 1999	Rutgers University, New Jersey, USA	Materials Science and Engin.
M.S	June, 1997	Rutgers University, New Jersey, USA	Ceramic and Materials Engin.
M.E	May, 1995	Indian Inst. of Science, Bangalore, India	Metallurgy
B.Tech	May, 1993	Indian Inst. of Technology, Kanpur, India	Metallurgy and Materials Engin.

Major Scholastic Achievements:

- ~340 publications in journals, books, magazines, patents and conference proceedings
- ~30 best-paper and other technical achievement awards in various IEEE and other Conferences.
- ~10 Million Dollars of fund-raising, mostly from industry
- >30 MS and PhD students – Co-advised or mentored
- ~25 invited presentations in technical conferences, at industry executive board, technical society webinars
- Associate Director, Industry Consortium on Power and RF Module Integration, Georgia Tech Packaging Research Center with focus on 3D passive component integration : Qualcomm, TDK-EPCOS, Intel, Texas Instruments, Medtronic, Maxim Integrated, Infineon, Nitto Denko, NGK-NTK, Rockwell Collins, Honeywell Inc., Applied Materials, Asahi Glass, Nagase, Namics Inc.
- IEEE Nanotechnology Council, Distinguished Lecturer 2020
- Associate Editor for IEEE Transactions on Components, Packaging and Manufacturing Technologies and IEEE Nanotechnology Magazine
- Committee Chair: Nanopackaging Technical Committee of IEEE Electronic Packaging Society (EPS) and Nanopackaging Technical Council (NTC), ECTC High-speed wireless and components (2017)
- Technology roadmapping: Heterogeneous integration (IEEE EPS) – Power passives components and materials, Printed Circuit Boards (IPC), 3D Power Packaging (PSMA),
- 25 invited talks in IEEE conferences, industry technology boards, technical society webinars
- Developed first 3D glass LTE diversity module, and 3D glass antenna-integrated package module for 5G mm wave applications;
- Developed substrate-integrated high-density power inductors and power capacitors for integrated power modules and voltage regulators;
- Developed embedded embedded-flex and fan-out packaging for wearables and implantables
- Industry Short Courses on Embedded Components and Heterogeneous Integration: Offered at multiple conferences as short courses, society webinars and lectures

PRIOR EMPOLYMENT HISTORY:

Georgia Tech, Packaging Research Center

Associate Research Director,	2017-2018
Research Program Manager,	2009-2017
Assistant Research Director,	2005- 2009
Technical Leader,	2003-2005
Post-Doctoral Fellow	1999-2003

AWARDS AND RECOGNITIONS:

A. Research Recognition Awards

1. IEEE Nanotechnology Council, Nanotechnology Distinguished Lecturer, 2020
2. IEEE Transactions of Components, Packaging and Manufacturing Technologies – Best Associate Editor Award
3. ***IEEE CPMT Japan Chapter Young Award (Atom Watanabe, Mentored by P Markondeya Raj),*** for *the* paper entitled: "Design and Demonstration of Ultra-thin 3D Glass-based 5G Modules with Low-loss Interconnects", International Conference on Electronics Packaging (ICEP), held in Mie, Japan, Fall 2018
4. ***Intel Best Student Paper Award (Muhammad Ali, Mentored by P. Markondeya Raj),*** 2019, for the paper entitled "Miniaturized High-Performance Filters for 5G Small-Cell Applications.", IEEE 68th Electronic Components and Technology
5. ***Best paper award,*** IEEE Nanotechnology Materials and Devices Conference (NMDC)", Carmine Gianfagna, Madhavan Swaminathan, P M Raj, Rao Tummala, Giulio Antonini, Enabling Antenna Design with Nano-Magnetic Materials using Machine Learning, Presented at Anchorage, Alaska, Sept 13-16, 2015
6. ***Best of Track (Advanced Packaging)***, at the *49th International Symposium on Microelectronics*, 2016, October 10th-13th in Pasadena, United States, "Electrodeposited copper-graphite composites for low-CTE integrated thermal structures", Shreya Dwarakanath, P M Raj, Vanessa Smet, Venky Sundaram, Rao Tummala
7. ***"IEEE EPTC Outstanding Technical Paper Award"***, *6th Electronics Packaging Technology Conference (EPTC 2004),* "High Frequency Characteristics of Supercapacitive Nanocomposite Thin Films and Their Suitability for Embedded Decoupling**" P.Markondeya Raj,** D. Balaraman, V. Govind, L.X. Wan, R. Abothu, R. Gerhardt, S. Bhattacharya, M. Swaminathan and R. Tummala, *Georgia Institute of Technology,* USA, 2005
8. ***"Distinguished Committee Service Award 2017,"*** from Institute for Printed Circuits (IPC) — Association Connecting Electronics Industries, in recognition of contributions to IPC-7091, Design and Assembly Process Implementation for 3D Components
9. ***Finalist, best conference paper, IEEE-NANO 2014***, "Tunable and Miniaturized RF Components with Nanocomposite and Nanolayered Dielectrics" **P. M. Raj**, Parthasarathi Chakraborti, Saumya Gandhi, Himani Sharma, Srikrishna Sitaraman, Kyuhwan Han, Madhavan Swaminathan and Rao Tummala
10. ***"IEEE Transactions on Advanced Packaging, Commendable Paper of 2004"***, "The SOP for miniaturized, mixed-signal computing, communication, and consumer systems of the next decade", Tummala, R.R.; Swaminathan, M.; Tentzeris, M.M.; Laskar, J.; Gee-Kung Chang; Sitaraman, S.; Keezer, D.; Guidotti, D.; Zhaoran Huang; Kyutae Lim; Lixi Wan; Bhattacharya, S.K.; Sundaram, V.; Fuhan Liu; **Markondeya Raj, P**
11. ***Best Poster Award***, *IEEE Electronic Components and Technology Conference, 2011*, H. Sharma, K. Sethi, **P. M. Raj**, Venky Sundaram, and Rao Tummala, "Conformal Atomic Layer Deposition (ALD) of Alumina on High Surface-Area Porous Copper Electrodes to Achieve Ultra-High Capacitance Density on Silicon Interposers
12. ***Medtronic MBTS – Invention of Distinction,*** "Systems and methods for providing high-density capacitors", Inventors: **P. M. Raj**, Rao Tummala, Himani sharma, Kanika Sethi (Georgia Tech., PRC), Anna Malin and Andy Fenner (Medtronic Microelectronics Corp), August 26, 2009
13. ***"Philips Best Paper Award"***, *International Conference on Electronic Packaging Technology (ICEPT*), China, August 2005, "Design, Simulation and Measurements of High-Speed Embedded Decoupling Capacitors for Multi GHz Packages/PCBs" (Lixi Wan, **P. M. Raj**, Rao Tummala and M. Swaminathan)
14. "***Best Paper of the Session***", Emerging Technologies Session, Novel Low-Cost Sol-Gel Derived Nano-structured and Repairable Interconnects, 36th International Symposium on Microelectronics, Sponsored by *International Microelectronics and Packaging Society (IMAPS),* 2003 Boston; Ankur Aggarwal, **P. M. Raj**, Isaac Robin Abothu, Michael D. Sacks and Rao Tummala

15. "***Best paper of the Session***", Integral passives, Low-cost embedded capacitor technology with hydrothermal and sol-gel processes *9th International Symposium on Advanced packaging Materials: Processing, Properties and Interfaces,* 2004; Devarajan Balaraman, **P. M. Raj**, Isaac Robin Abothu and Rao Tummala

16. ***Distinguished Scholar Award***, **1998** - Awarded by the Microbeam Analysis Society, USA; Edge sharpening for unbiased edge detection in FESEM images. Presented at the symposium on applied image processing, *Annual Microscopy and Microanalysis Meeting*, Atlanta, July, 1998

17. ***First Place - Best Student Paper,*** *First International workshop on Future Car Electronics,* Nov. 8-9, 2016, Atlanta, Atom Watanabe, **P. M. Raj**, Rao Tummala, Denny Wong, Ravi Mullapudi, Sven Lamprecht, Robin Taylor, Title: Highly-effective Integrated EMI Shields

18. ***Best Student Paper award*** at the *49th International Symposium on Microelectronics*, 2016 held October 10th-13th in Pasadena, United States, "Electrodeposited copper-graphite composites for low-CTE integrated thermal structures", **Shreya Dwarakanath, P M Raj,** Vanessa Smet, Venky Sundaram, Rao Tummala

19. ***Motorola CPMT Fellowship Award,*** **Tapobrata Bandyopadhyay**, Gaurav Mehrotra, Mahadevan K. Iyer**, P. M. Raj,** Madhavan Swaminathan and Rao R. Tummala, "Microwave Design & Characterization of a Novel Nano-Cu Based Ultra-fine Pitch Chip-to-Package Interconnect", 58th *Electronic Components and Technology Conference*, Orlando, May 2008

20. 'Best Interactive Presentation Paper' at *IEEE ECTC 2015* - San Diego**, Ninad Shahane**, **P.M. Raj** Modeling, Design and Demonstration of Low-Temperature, Low-Pressure and High-Throughput Thermocompression Bonding of Copper Interconnections without Solders

21. **Best Student Paper (Third Place): Ninad Shahane**, **P.M. Raj** Low-temperature copper interconnections without solders, at *2015 IEEE Global Interposer Technology Workshop*

22. ***Third Place - Best Student Paper,*** *First International workshop on Future Car Electronics,* Nov. 8-9, 2016, Atlanta, Title: Integrated Magnetic Substrates for High-frequency DC-DC Converter in (H)EV Applications. **Haksun Lee**, Vanessa Smet, **P.M. Raj** and Rao Tummala

23. **Best Student Paper (Third place):** Tantalum based high density capacitor with low leakage for high frequency and low power applications **Partha Chakraborti**, **P.M. Raj**, *2015 Global Interposer Technology Workshop*, Atlanta, Nov

24. "***Intel Best Student Paper Award***", New paradigms for IC-package reworkable nanointerconnects, *Electronic Components and Technology Conference – ECTC 2004* (Student: **Ankur Aggarwal**, Co-authors: Rao Tummala and **P. M. Raj**)

25. ***"Best Student Paper (First Place),*** **Dibyajat Mishra**, **P. M. Raj** and Rao Tummala, *Multilayered ferromagnetic-polymer composite structures and their integration into high-density power supply inductors, Third Annual Global Interposer Technology workshop*, Nov. 20, 2014

26. "***Best Student Paper*** (***Third place***), **Ting-Chia Huang**, Vanessa Smet, Satomi Kawamoto, **P. M. Raj,** Rao Tummala, Metastable Cu-Sn interconnections for high-throughput ultra-fine pitch SLID bonding, *Third Annual Global Interposer Technology workshop*, Nov. 20, 2014

27. "***Best Student Paper*** (***Third place***), **Ninad Shahane**, Scott McCann, Vanessa Smet, **P. M. Raj,** Rao Tummala, Low-temperature low-pressure Cu interconnections without solders at fine pitch, *Third Annual Global Interposer Technology workshop*, Nov. 20, 2014

28. ***"Best Student Paper (Third place)",*** **Parthasarathi Chakraborti**, Himani Sharma, **P. M. Raj,** Rao Tummala, *Third Annual Global Interposer Technology workshop*, Nov. 20, 2013

29. ***IEEE CPMT ECTC Travel Award***, **Dibyajat Mishra**, *Electronic Components and Technology Conference*, Highly-loaded metal nanoparticles in insulators for high-frequency magnetic films, Dibyajat Mishra, K P Murali, **P. M. Raj**, Himani Sharma and Rao Tummala

30. ***IEEE CPMT ECTC 2011 Travel Award***, **Kanika Sethi** - *IEEE Electronic Components and Technology Conference,* H. Sharma, K. Sethi, **P. M. Raj**, Venky Sundaram, and Rao Tummala, "Conformal Atomic Layer Deposition (ALD) of Alumina on High Surface-Area Porous Copper Electrodes to Achieve Ultra-High Capacitance Density on Silicon Interposers

31. ***Second Prize at the "Regional Science Fair"*,** **Arulita Gupta (High School Intern),** Nitesh Kumbhat, **P. M. Raj**, Rao Tummala, "Compliant Silicon/Glass Interposer to PWB Interconnection"
32. SECOND PLACE - Second International Workshop on Future Car Electronics (FCE), November 8-10 2017, Georgia Learning Center, Atlanta, Shreya Dwarakanath, Raj Pulugurtha, Etizaz-Shah Hassan, Vanessa Smet, Venky Sundaram, Mark Losego and Rao Tummala, "High-Temperature reliability of high-density power packages for electric vehicles"
33. SECOND PLACE - Second International Workshop on Future Car Electronics (FCE), November 8-10 2017, Georgia Learning Center, Muhammad Ali, Raj Pulugurtha, Venky Sundaram and Rao Tummala, "High-performance mm-wave passive components for V2X and V2V connectivity"

Other Recognitions

1. Outstanding Staff Achievements Award, 2005 from the Packaging Research Center, Georgia Institute of Technology (for publications and research funding).
2. Outstanding Student Mentor Award, from the Packaging Research Center, Georgia Institute of Technology, March 2016.
3. Outstanding Student Mentor Award, from the Packaging Research Center, Georgia Institute of Technology, March 2015.
4. Best of the Best - Outstanding Research Mentor Award, from the Packaging Research Center, Georgia Institute of Technology, March 2014.
5. Georgia Tech. Certificate of Excellence, for volunteering as STEM (Science, Technology, Engineering and Mathematics) outreach Ambassador for local high school students.
6. First Rank, National (India) Graduate Aptitude Test in Engineering (GATE), 1993 Metallurgy.
7. First Rank, Metallurgy Department, ME, Indian Institute of Science, Bangalore, Class of 1995.

Special Activities

1. Panelist for National Science Foundation.
2. Mentor for Senior Design Projects:
   1. Field Therapy Accelerator for Wound Healing, Marisol Roman, Paulo Castro, Jorge Garcia, Jarvin Kelly, Dayan Rodriguez, Spring 2020.
   2. Wearable Bioelectronic Systems with Next Generation Device Assembly Technologies Antony Arun Maria, Prashant Gautam, Jessica E. Molina, John Murnin, Dennis Ramos Trinidad; Sponsored by Jabil
   3. Wireless Power Transfer System, Christopher Bolig, Micheal Clarke-Wilson, Zachary Forbes, Kevin Mata, Joshua Holoman, ECE, Spring 2020
   4. WhereAbouts with RFID tags, William Fernandez, Johnathan Duque, Jordan Lewis, Tidjan Simpson, Saad Alsafeh, Summer 2019
   5. NeuroBeats: A Wearable Stimulator for Parkinson's Disease, Vanessa Guevara, Kelsey Quevedo, Jose Solis, Jorge Barter, Fall 2019
   6. Field Therapy Accelerator, Lina Bernier-Colon, Shebin George, Valentina Melero, Claudia Pinochet, Spring 2019

Invited Presentations:

1. Heterogeneous System Integration with Nanopackaging, IEEE Distinguished Lecture Series, 2020,
   - Nanotechnology Council, Northern Virginia/Washington Jt. Sections.
   - IEEE NANOTECHNOLOGY, 2020, July 29-31.
   - 26th IEEE International Symposium for Design and Technology in Electronic Packaging (IEEE-SIITME) and as the chair of the IEEE Hungary & Romania Joint EPS & NTC Chapter, Pitesti, Romania on October 21st–24th, 2020
   - International Conference (in online mode) on Emerging Electronics (ICEE-2020) at the Indian Institute of Technology, Delhi, India from 26th – 28th Nov 2020
2. Invited Speaker, Micro Device Fabrication & Material Analysis Workshop Outline March 6-7, 2020 Advanced Materials Engineering Research Institute, AMERI,

3. **(Plenary Speaker)**, Applied Power Electronics Conference (APEC), "3D Power Packaging made Real with Embedded Component and Substrate Technologies," Plenary session on Monday, IEEE March 5-8, 2018
4. **(Invited Speaker) P M Raj**, **Nanostructures for Enabling Implantable Bioelectronic Systems**, *IEEE Nanotechnology Materials and Devices (NMDC)*, Portland, Oregon, October 14-17, 2018

5. **(Invited Speaker)** 3D Passive Component Integration for Power Conversion and Delivery, 2018 Electronics Packaging Symposium that GE co-hosts with Binghamton University Sept 17-19, Binghamton, New York.

6. **Invited Webinar Speaker**, Power Sources Manufacturers Association (PSMA), Product Technology Roadmap Presentation, October 4, 2018, Emerging Embedded Passive Technologies that Enable High-Density 3D Power Packaging with Roadmap Projections

7. **(Invited Industry Short Course Instructor)**, Passive Components and Integration for Power and RF Modules, P. Markondeya Raj, Georgia Tech – Packaging Research Center, 22nd Annual Components for Military & Space Electronics Conference & Exhibition, May 7-10th, 2018, Four Points by Sheraton (LAX), Los Angeles, California

8. **(Invited Speaker),** Industry Session on Innovative Component, Reliability and Manufacturing for 3D Power Packaging Solutions, Title: Embedded passives – Recent Advances and Opportunities , *Advanced Power Electronics Conference, APEC 2018*, March 5-8, San Antonio, Texas

9. **(Invited Speaker),** *Integrated Power Conversion and Power Management (PwrSoC*), Title: Reliability and Manufacturing Readiness of High-Density (1 mF/mm2) Ultra-thin (75 microns) Wafer- or Package-integrated Film Capacitors, October 17-19, 2018, Hsinchu, Taiwan

10. **(Industry Short Course Instructor)**, Passive Components and Integration for Power and RF Modules, P. Markondeya Raj, Georgia Tech – Packaging Research Center, 22nd Annual Components for Military & Space Electronics Conference & Exhibition, May 7-10th, 2018, Four Points by Sheraton (LAX), Los Angeles, California

11. **(Invited Speaker),** *Integrated Power Conversion and Power Management (PwrSoC*), Title: Reliability and Manufacturing Readiness of High-Density (1 mF/mm2) Ultra-thin (75 microns) Wafer- or Package-integrated Film Capacitors, October 17-19, 2018, Hsinchu, Taiwan

12. **Panel Speaker,** Industry Session on 3D power packaging, "Emerging passive component technologies for power modules", Advanced Power Electronics Conference, APEC 2017, March 28-30, Orlando

13. **Invited Talk,** International Conferences for Power Sources on Chip, "High-density capacitors on silicon", October 3-5, 2016, Madrid, Spain

14. **Invited Talk**, System Scaling as new electronic systems frontier with frontier materials, Symposium on "Material Frontiers in Semiconductor Advanced Packaging" at the 2016 Spring MRS Conference in Phoenix, AZ (March 28-April 1, 2016)

15. **Distinguished Professor Lecture**, "Capacitors and their integration", Texas Instruments, Santa Clara April 16, 2015.

16. **Invited Talk**, Third Annual Global Interposer Technology workshop, Nov. 20, 2014, "Miniaturized RF, Power and Bioelectronic modules using Nanoscale Component Integration"

17. **Invited Talk,** Integration of Power-Supply Capacitors with Ultrahigh Density on Silicon Using Particulate Electrodes " International Conferences for Power Sources on Chip", November 17, 2012.

18. **Invited Panel Speaker** on "Hermetic Packaging", IEEE Neural Interfaces Conference, June 17, Cleveland, Ohio, 2008.

19. **Invited Talk** "SOP For Miniaturized Multifunctional Wearable Electronics", Oral presentation within Track #1, Technical Session #4 (Enabling Technologies II), Future technologies Conference, National Nuclear Security Administration, October 10-13, Washington DC., 2006

20. **Invited Talk,** "SOP for Miniaturizing Implantable Devices", Medtronic's Quarterly Technical Review, Minneapolis, MN, Aug 5, 2008.

21. **Invited Panel speaker**, "Wafer Level Packaging", "DuPont's Quarterly Technical Review, April 12, 2006

SERVICES:

- Associate Editor IEEE Nanotechnology Magazine
- Associate Editor IEEE Transactions on Components, Packaging and Manufacturing Technologies
- Co-Chair, IEEE CPMT Technical Committee on "Nanopackaging"; 2013-
- Co-Chair, IEEE Nanopackaging Technical Committee
- Chair, IEEE ECTC High-Speed wireless and components, 2016-2017.
- IEEE CPMT US Representative for Nanotechnology Research Council, 2013-
- GUEST EDITOR, P. Markondeya Raj and Ravi Mahajan, Nanopackaging, IEEE Transactions on Components, Packaging and Manufacturing Technologies (CPMT), December 2016.
- Power Sources Manufacturers Association (PSMA) lead for their third Industry Technology Survey report (2017-2018)
- Heterogeneous Integration Roadmap (Passive Components – Materials and power components: contributed technical summary and future trends)
- Chair, IEEE Webinar for Electronic Packaging Society, Implantable Electronics: Emerging Packaging Needs, Challenges and Recent Industry Breakthroughs, Feb 4, 2020
- Host, IEEE EPS Distinguished Lecturer, FAN-OUT PACKAGING FOR FUTURE ELECTRONICS AND BIOELECTRONICS, Feb 18, 2020
- Co-Chair, FIU Biomedical Engineering, Industry Advisory Board, 2019-2020.
- Session Chair, IEEE Electronic Components and Technology Conference, ECTC
    - 2021 (3D power components and power integrity)
    - 2020 (power components and modules) – with Rockwell Hsu,
    - 2019 (high-bandwidth packaging) – with Amit Agarwal
    - 2017-2018 (power delivery and integrity) – with Rajen Murugan
    - 2014 Session Chair, IEEE Electronic Components and Technology Conference, Integrated Power and RF Modules (Co-Chair: Rockwell Hsu, CISCO Systems Inc.)
    - 2013, Session Chair, IEEE Electronic Components and Technology Conference, System Components for RF and mm wave (Co-Chair: Prof. Lih-Tyng Hwang, National Sun Yat-Sen, University), Lake Buena Vista, FL
    - 2012, MEMS Integration and Processing (Co-Chair, John Cunningham, Oracle), San Diego, CA.
- Session Chair, Capacitors and Energy Storage, Power Sources on Chip, Pittsburgh, October 25-28, 2020
- Track Chair for Nanopackaging, IEEE Nanotechnology Conference, July 29-31, 2020, 2021, Montreal, Canada.
- Organizing Committee, , IEEE Nanotechnology Materials and Device Conference, October 17th to 20th, 2021.
- Session Chair, 3D PEIM (Power Electronics Integration and Manufacturing), Heterogeneous component integration, June 2018
- Session Chair, Nanopackaging Session, IEEE Nanotechnology Materials and Devices Conference 2018, Pittsburg, USA
- Session Chair, Nanopackaging Session, IEEE Nanotechnology Conference 2017, Pittsburg, USA
- Session Chair, Nanopackaging Session, IEEE Nanotechnology Conference 2015, Rome, Italy.
- Session Chair, Future Car Electronics, High-temperature packaging, 2017, Atlanta, USA
- Session Chair, Future Car Electronics, High-temperature packaging, 2016, Atlanta, USA
- Session Chair, Global Interposer Technologies (GIT, 2014), Power and RF modules, USA
- Session Chair, Global Interposer Technology Workshop (GIT, 2012), Integrated Passive Devices, USA
- Session Chair, IEEE Electronic Components and Technology Conference, 2014, Integrated Power and RF Modules (Co-Chair: Rockwell Hsu, CISCO Systems Inc.)

- Session Chair, IEEE Electronic Components and Technology Conference, 2013, System Components for RF and mm wave (Co-Chair: Prof. Lih-Tyng Hwang, National Sun Yat-Sen University), Lake Buena Vista, FL.
- Member, Institute of Electrical and Electronic Engineers IEEE, 2008-date
- Member, Power Source Manufacturers Association (PSMA) (2017-)
- Past Member, American Ceramic Society (1997 – 2004)
- Past Member, Microbeam Analysis Society (1997 -1999),
- Member, International Microelectronics and Packaging Society (IMAPS) (2000-2005, 2019-).

STEM Outreach Activities

- Hosted elementary school students for Science Demonstrations at Georgia Tech (Nanoenergy, bioelectronics) – 12/5/2016, 2017,
- STEM Science Career Fair, Trickum Middle School, 11/19/2014
- Science Demonstrations at Arcado Elementary School (Lilburn, GA) on electromagnetism, electromagnetic induction and transformers (4/28/2014)
- Science Demonstrations at Arcado Elementary School (Lilburn, GA) on heat-generation in electronics and chip cooling with heat-sinks and thermal interface materials (3/10/2012)
- Hosted several semiconductor and packaging companies as a part of PRC promotion and fund-raising

Key Delivered Products

1. ***Silicon-integrated high-density capacitors***: Process-of-record, yield and reliability data, supply-chain and commercialization path, to Texas Instruments, AVX and HCStarck; Raj is the program manager for this project
2. ***Substrate-integrated inductors***: Intellectual property, design, Process-of-record and samples for integrated inductors to Nitto Denko Corp and Advanced Microdevices; Raj is the program manager for this project
3. ***3D IPD diplexers***: Design, process-of-record, fabrication and model-to-hardware correlations for glass-based 3D IPD diplexers, supply-chain and commercialization path; Raj is the program manager for this project
4. ***3D IPAC LTE modules***: Design, process-of-record, fabrication and model-to-hardware correlations for glass-based 3D integrated passive and active component modules, supply-chain and commercialization path; Raj is the program manager for this project
5. ***Compliant board-level interconnections:*** Microwire array technology – process, reliability characterization data for board-level reliability - to Qualcomm Inc.; Raj is the program manager for this project
6. ***Fine-pitch Cu interconnections without solders:*** Process development, fabrication and reliability characterization of 30 micron pitch Cu interconnections to Intel, TI, Infineon; Raj is the task leaders for this project
7. ***High-density capacitor array***, (Medtronic), 2008-2010 - This prototype demonstrates the ability to integrate multiple capacitors on a single Integrated Passive Device (IPD) that can be embedded in a 3D package; This technology can miniaturize medical devices such as pace-makers; Raj is the Project Leader and Program Manager
8. ***Novel nanomagnetic planar antennas*** (Intel), 2010-2012- This prototype shows antenna miniaturization with a novel nanomagnetic dielectric; This technology can miniaturize broadband antennas in a mobile product; Raj is the Project Leader
9. ***Embedded thin-film ceramic capacitor prototypes*** (NGK-NTK, Korean Electronics Technology Institute) 2004-2009, This prototype shows high reliability and low leakage currents with a thin-film capacitor that is compatible with organic packages; Raj is the Project Leader
10. ***Integrated thin-film Resistor and Capacitors in organic packages*** (Army Research Labs), 2006-2008, This prototype demonstrate simultaneous resistor and capacitor integration on a novel ceramic composite substrate. Raj is the Project Leader

11. ***High-density planar thin-film capacitors*** (Texas Instruments), 2009-2010 – This prototype show integration of thin-film capacitors on silicon for a medical implant application - Raj is the Project Leader

Academic Courses Taught

Semester (Year) (# of Lectures)	Topic and Course number	Other Instructors	Number of Students
2019, 2020 and 2021, Spring	BME 3721 Data Evaluation Principles		3150
2021, Spring	Engineering Data Evaluation		35
2020, Fall	Biomedical Device Design		10
2019, Fall	Miniaturized Neuroelectronics		16
2018, Fall	BME 4990 Bioelectronic Packaging		9
2013-2017 2008-2011	ECE 4754 Electronic Packaging Module Assembly	With Prof. Rao Tummala and Dr. Vanessa Smet	15-20
2000-2005 (1 Lecture) 2005-2017 (3-4 Lectures)	ECE 6776 Packaging materials and passive components	With Prof. Rao Tummala	50-60
Spring, 2007, 2008 (1 Lecture)	ECE 4460 Passive components	With Prof. M. Swaminathan	8-10
Fall, 2008-2011 (2 Lectures)	ECE 4755 Packaging materials and passive components	With Prof. Rao Tummala, Dr. Venky Sundaram	8-10
Spring 2013	MSE 4803 Magnetic components	With Dr. Erik Shipton	8-10

Continuing Education Courses Taught

1. Co-instructor for Short course, 3D and nanosystems, Offered at the *59th Electronic Component an d Technology Conference, ECTC 2009*, May 28, 2009

2. Industry Short Course: Passive Components and Integration for Power and RF Modules, International Microelectronics and Packaging Society (IMAPS) 2019, Boston, 9/30/19 – 10/3/19

3. **(Invited Industry Short Course Instructor)**, Passive Components and Integration for Power and RF Modules, P. Markondeya Raj, Georgia Tech – Packaging Research Center, 22nd Annual Components for Military & Space Electronics Conference & Exhibition, May 7-10th, 2018, Four Points by Sheraton (LAX), Los Angeles, California
   1.

Curriculum and/or Short Course Development

4. Developed short courses on 3D systems packaging with systems scaling, (with Prof. Tummala and the PRC team), *Electronic Component and Technology Conference*, Offered 2010-2017

5. "3D and Nanosystems", Offered at the *IEEE 59th Electronic Component and Technology Conference*, ECTC 2009, May 28, 2009

6. Developed short course on: System-On-Package (with Prof. Tummala and the PRC team), *Electronic Component and Technology Conference*, Offered 2000-2008

PUBLICATIONS

Published Books and Parts of Books

1. Shubhendu Bhardwaj, Raj (Markondeyaraj) Pulugurtha, John L. Volakis, *High Density Electronic Integration for Wearable Sensing, in "Antenna and Sensor Technologies in Modern Medical Applications", Editors: Yahya Rahmat Sami and Erdem Topsakal.*

2. **P. M. Raj,** Parthasarathi Chakraborti, Srikrishna Sitaraman, Saumya Gandhi, John

Prymak, Swapan Bhattacharya; "Passives and integration with actives to form power and RF modules", *Fundamentals of Microelectronic Systems Packaging*, Editor: Tummala, R. R; McGraw Hill Publications, August 2017

3. **P. Markondeya Raj**, Melinda Varga and Rao Tummala, Applications of Packaging Technologies in Bioelectronics Fundamentals of Electronic Device and Systems Packaging Technologies, 2019

4. Muhammad Ali, **P Markondeya Raj** and Rao Tummala, Applications of Packaging Technologies in Communication Systems, Fundamentals of Electronic Device and Systems Packaging Technologies, 2019

5. Siddharth Ravichandran, **Markondeya Raj Pulugurtha**, Vanessa Smet, Rao Tummala, , Applications of Packaging Technologies in Flexible Electronics, Fundamentals of Electronic Device and Systems Packaging Technologies, 2019

6. Srikrishna Sitaraman, Manos Tentzeris, John Papapolymerou and **P. M. Raj**, "Fundamentals of RF and 5G packaging", *Fundamentals of Microelectronic Systems Packaging*, Editor: Tummala, R. R.; McGraw Hill Publications, August 2017

7. Himani Sharma, **P M Raj**, Shreya Dwarakanath, "Micro and nanopackaging materials", *Fundamentals of Microelectronic Systems Packaging*, Editor: Tummala, R. R.; McGraw Hill Publications, August 2017

8. Chandra Nair, Venky Sundaram and **P M Raj**, "Fundamentals of Packaging substrate materials, *Fundamentals of Microelectronic Systems Packaging*, Editor: Tummala, R. R.; McGraw Hill Publications, August 2017

9. **P. M. Raj**, D. W. Lee, L. Li, S. X. Wang, P. Chakraborti, H. Sharma, S. Jain, and R. Tummala, "Embedded Passives," *Materials for Advanced Packagin*g, pp. 537-588: Editors: Daniel Lu and C P Wong; Springer International Publishing, 2017

10. **P. M. Raj**, Teng Sun, Gopal C. Jha, Swapan K. Bhattacharya and Rao R. Tummala. "Nanogranular magnetic core inductors: Design, fabrication and packaging", *NANOPACKAGING: Nanotechnologies & Electronics Packaging*, J E Morris, Ed. Wiley: 2nd edition

11. **P. M. Raj**, Parthasarathi Chakraborti, Dibyajat Mishra, Himani Sharma, Saumya Gandhi, Srikrishna Sitaraman and Rao Tummala, "Nanostructured passive components for power and RF applications," *Nanopackaging – from nanomaterials to the atomic scale*, Edited by Xavier Baillin and Poupon Gilles; Springer

12. **P. M. Raj**, Dibyajat Mishra, Erik Shipton, Himani Sharma and Rao Tummala; "Nanomagnetic Structures, Properties and Applications In integrated RF and Power Modules and Sub-systems," *Nanomagnetism*, Edited by: Julian Gonzalez; One Central Press, UK; Appeared online in 2014, pp. 1-28

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Selected Conference Presentations without Proceedings

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2. P M Raj, Shekhar Bhansali, Shubhendu Bhardwaj and John Volakis , 3D Component Integration in Smart Sensor Packages, International Microelectronics and Packaging Society, Florida Chapter, 2018

3. 2018 Electronics Packaging Symposium that GE co-hosts with Binghamton University **(Invited talk)** Industry Session on 3D power packaging, Title: Emerging passive component technologies for power modules, *Advanced Power Electronics Conference, APEC 2017*, March 28-30, Tampa

4. **(Invited Talk),** Title: *International Conferences for Power Sources on Chip (PwrSoC*), Title: High-density capacitors on silicon, October 3-5, 2016, Madrid, Spain

5. **(Invited Talk)**, System Scaling as new electronic systems frontier with frontier materials, Symposium on "Material Frontiers in Semiconductor Advanced Packaging” at the 2016 Spring *MRS Conference* in Phoenix, AZ (March 28-April 1, 2016)

6. **(Invited Talk)**, *Third Annual Global Interposer Technology workshop*, Nov. 20, 2014, Title: Miniaturized RF, Power and Bioelectronic modules using Nanoscale Component Integration

7. **(Invited Talk),** Title: Integration of Power-Supply Capacitors with Ultrahigh Density on Silicon Using Particulate Electrodes " *International Conferences for Power Sources on Chip*”, November 17, 2012

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Reviewer for several journals, some of which are listed here:

1. Material Chemistry and Physics
2. IEEE Transactions on Electronic Devices
3. Journal of inorganic and organometallic materials and polymer
4. ACS Applied Materials and Interfaces
5. IEEE Components, Packaging and Manufacturing Technology Transactions;
6. ASME Journal of Electronic Packaging
7. Journal of Materials Science D – Materials in Electronics
8. Philosophical magazine and philosophical magazine letters
9. Materials, Multidisciplinary Publishing Institute
10. Journal of Alloys and Compounds
11. Microelectronics Engineering
12. Electrochemical and Solid State Letters
13. American Ceramic Society
14. European Ceramic Society,
15. Powder Technology
16. Materials Research Bulletin