



46th Electronic Materials Symposium

A Brief History

James Spallas, Chairman
Benson Memorial Center
Santa Clara University
May 4, 2018

EMS 2018 Steering Committee

Dragoslav Grbovic, Toshishige Yamada, Alberto Salleo, Jeongwon Park, Jie Yao, Ernesto E. Marinero, Johnathan Fan, and Ning Cheng

Taking Care of Business

- Thank you's
- Ralph Krause, Ross Tucker and Best Post Awards
- Two poster sessions
 - *Novel approach to valleytronics in IV-VI monochalcogenides; S. Lin, et al., U.C. Berkeley*
- Yes ... we have alcohol (and cheese plates)
- What about lunch
 - Lunch speaker begins at 1:15 pm
- What about restrooms
- Yes ... we have a Survey



When I say “History,” I Really Mean ...

- “History” focusing primarily on speakers
- Reviewed 45 years of EMS programs
- Exacting process: Google
 - First cut ... did they have a Wikipedia page
 - Second cut ... contribution to their field, historical relevance, chairman’s choice
- Too many outstanding invited speakers to mention in this discussion
- Many multiple-award winners didn’t “make the cut”
- Not all awards are listed for highlighted speakers
 - Enrico Fermi Award, Albert Einstein Award, National Medal of Science, IEEE Medal of Honor, Feynmann Prize, and many more
- I may have missed some “stars”
 - $8 \times 45 = 360$ names and titles to investigate
- Please forgive any unintended oversights

Past Speakers at Glance

- Two Nobel Prize winners
- Three Presidential Medal of Freedom winners
- One Time Magazine Man of the Year
- A Knight and a Baron
- Two Astronauts
- Traitorous Eight
- Father of ... the Hydrogen Bomb, MEMs Systems, Astrobiology, Photonic Crystals, and Solar Power in the US
- “Queen of Carbon Science,” “Mayor of Silicon Valley,” and “Most Isolated Human Being”
- “Moore's Law,” “Swanson's Law,” “Early Effect,” and “Nemesis – the Death Star”
- Inventor of the Transistor, Integrated Circuit, AFM, Yellow, Red and Orange LEDs, GaAs FET, Commercial Laser Diode, Epitaxial Silicon Solar Cell, Silicon Wire Array Solar Cell, Transcriptor, Yablonovite, Merkle Trees, Cryptographic Hashing, and Gene Gun
- Founders of Shockley Semiconductor Laboratory, Intel, Fairchild, Cypress Semiconductor, SunPower, Cepheid, Incubit Ventures, New Focus, EAG, Synaptics, Actel, SUNY Polytechnic Institute, Novelx, and many more

Top Speaker Affiliations

- IBM (San Jose and Yorktown Heights): 48 (13%)
- Stanford: 37 (10%)
- Intel: 29 (8%)
- U.C. Berkeley: 25 (7%)
- HP (18) / Agilent (6): 22 (6%)
- Xerox: 19 (5%)

In the Beginning

The Cabana Hotel, at 4290 El Camino Real in Palo Alto, was Palo Alto's most glamorous hotel. It was so glamorous, in fact, that it was completely out of place in Palo Alto. The hotel was built in 1962 by entrepreneur Jay Sarno, and Doris Day was one of the original investors. The flashy, Roman-themed design was apparently the blueprint for Caesar's Palace. The Cabana has a permanent place in South Bay mythology because The Beatles stayed there when they played San Francisco in 1965.

San Mateo Times (Nov. 10, 1967)

Home of the EMS
from 1973 - 1980



Speakers Through the Decades

1st EMS 1973, Cabana Hyatt House, Palo Alto, CA

- LUNCHEON SPEAKER: The Invention of The Transistor - Personal Reminiscences, Prof. William Shockley, Stanford University, Stanford, CA
 - 1956 Nobel Prize in Physics (with Bardeen and Brattain) for "their research on semiconductors and their discovery of the transistor effect"
 - Started Shockley Semiconductor Labs in Palo Alto (1956)
 - "Traitorous Eight:" Julius Blank, Victor Grinich, Jean Hoerni, Eugene Kleiner, Jay Last, Gordon Moore, Robert Noyce, and Sheldon Roberts, leave Shockley to form Fairchild Semiconductor (1957)
 - National Semiconductor (1965), Intel (1968), AMD (1969), Hewlett Packard (1972), etc., establishing a west coast semiconductor presence and the foundations of Silicon Valley
 - "Shockley is the man who brought silicon to Silicon Valley"
- Fundamental Limitations of Microelectronic Devices, Prof. Carver A. Mead, Caltech, Pasadena, CA
 - Designed the first gallium arsenide gate field-effect transistor using a Schottky barrier diode (1966)
 - Pioneer of modern microelectronics
 - Pioneer in VLSI design
 - Coined the term "Moore's Law" in 1975
 - Founded over 20 companies including Actel (1985) and Synaptics (1986)
- Semiconductor Memories, Dr. Andrew S. Grove, Intel Corporation, Santa Clara, CA
 - Intel President (1979), CEO (1987) and Chairman and CEO (1997)
 - 1997 TIME Man of the Year as "the person most responsible for the amazing growth in the power and the innovative potential of microchips"

Speakers Through the Decades

2nd EMS 1974, Cabana Hyatt House, Palo Alto, CA

- Trends in Integrated Electronic Technology (or Where Is This Silly Business Going Anyway?), Dr. Gordon Moore, Intel Corporation, Santa Clara, CA
 - “Traitorous Eight”
 - “Moore’s Law” first described in “Cramming More Components onto Integrated Circuits” (1965)
 - Co-Founded Intel (1968)
 - Presidential Medal of Freedom (2002)
 - National Inventors Hall of Fame (2009)
- Processing of Heterojunction Devices, Mr. Jerry M. Woodall, IBM Research, Center San Jose, CA
 - Invented the first commercially viable heterojunction material for red LEDs that are now used in automobile brake lights and traffic lights, CD and DVD players, TV remote controls and computer networks (1967)
 - National Medal of Technology ... “roughly half the annual \$5 billion in sales of gallium arsenide-based semiconductor devices could be traced to his work” (2001)
 - Cornell University, Ph.D. 1982
- Electron Beam Microfabrication, Dr. Edward D. Wolf, Hughes Research Laboratories, Malibu, CA
 - Co-Inventor of the Gene Gun (1983)
 - Dissertation adviser
- Personal Perspectives on Spacecraft Earth, Col. Al W. Worden, Ames Research Center, Moffett Field, CA
 - Command module pilot for Apollo 15, the fourth lunar landing mission (1971)
 - *Guinness Book of World Records* “Most isolated human being” for being 2,235 miles from any human while in lunar orbit

3rd EMS 1975, Cabana Hyatt House , Palo Alto, CA

- Some Psychoenergetic Experiments in the USA and the USSR, Prof. William A. Tiller, Stanford University, Stanford, CA
 - Author of *Science and Human Transformation* (Pavior 1997)... “the subtle energies beyond the four fundamental forces” which he believes act in concert with human consciousness

Speakers Through the Decades

4rd EMS 1976, Cabana Hyatt House , Palo Alto, CA

- New Electronic Materials, Dr. N. Bruce Hannay, Bell Labs, Murray Hill, NJ
 - Vice President of Bell Labs (1973 – 1982)
- Advances in High Resolution Lithography, Dr. Alec Broers, IBM Corporation, Yorktown Heights, NY
 - Vice Chancellor of Cambridge (1996 – 2003)
 - President of the Royal Academy of Engineering (2001)
 - Knighted in 1998 and granted life peerage as Lord Sir Alec Broers in 2004
- Materials and Processes Development - A Device View, Dr. James Early, Fairchild Semiconductor Labs, Palo Alto, CA
 - “Early Effect” in BJT’s first described in “Effects of space-charge layer widening in junction transistors” (1952)
- **PROJECT CYCLOPS - EXTRATERRESTRIAL COMMUNICATION, DR. BERNARD M. OLIVER, HP LABS, PALO ALTO, CA**
 - **INVESTIGATED HOW TO SEARCH FOR RADIO SIGNALS UP TO 1000 LIGHT-YEARS AWAY TO FIND INTELLIGENT LIFE**
 - **PIONEER IN THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)**
 - **FOUNDING DIRECTOR OF HP LABS**
 - **NATIONAL INVENTORS HALL OF FAME (2004)**
- Devices in Silicon Grown by the EFG Process, Dr. Henry Kressel, RCA Laboratories, Princeton, NJ
 - Developed the first practical laser diodes and the first epitaxial silicon solar cell while at RCA Labs

5th EMS 1977, Cabana Hyatt House, Palo Alto, CA

- Nuclear Energy - The People or the Politicians, Prof. Edward Teller, U.C. Berkeley, Berkeley, CA
 - Manhattan Project
 - “Father of the Hydrogen Bomb”
 - Presidential Medal of Freedom (2003)
- Epitaxial Regrowth of Implanted Amorphous Si, Prof. James H. Mayer, California Institute of Technology, Pasadena, CA
 - Dissertation adviser

Speakers Through the Decades

6th EMS 1978, Cabana Hyatt House, Palo Alto, CA

- Where is Silicon Technology Heading?, Dr. Robert N. Noyce, Intel Corporation, Santa Clara, CA
 - “Traitorous Eight” and “Mayor of Silicon Valley”
 - Co-Inventor of the Integrated Circuit (U.S. Patent 2,981,877 "Semiconductor Device and Lead Structure," 1956)
 - Co-Founded Fairchild (1957) and Intel (1968)
- V - MOS Technology, Dr. Thurman J. Rodgers, American Micro-Systems, Inc., Santa Clara, CA
 - Founded Cypress Semiconductor (1982)
- Materials Aspects of LSI Device Reliability, Dr. Craig R. Barrett, Intel Corporation, Santa Clara, CA
 - Intel President (1997), CEO (1998) and Chairman of the Board (2005)
- **UFO'S - BORDERS OF SCIENCE, PROF. ROBERT F. CREEGAN, STATE UNIVERSITY OF NEW YORK, ALBANY, NY**
 - **RESIGNED FROM NATIONAL ENQUIRES "BLUE RIBBON PANEL" TO INVESTIGATE UFO'S IN 1975 BECAUSE OF ERRORS AND FRAUD**

7th EMS 1979, Cabana Hyatt House, Palo Alto, CA

- Brave New World of VLSI, Prof. Carver A. Mead, Caltech, Pasadena, CA
- High Resolution Patterning for Integrated Circuits, Prof. S. Fabian Pease, Stanford University, Stanford, CA

8th EMS 1980, Cabana Hyatt House, Palo Alto, CA

- Integrated Circuits as Viewed Through the Acoustic Microscope, Prof. Calvin F. Quate, Stanford University, Stanford, CA
 - Co-Inventor of the AFM (1981)

9th EMS 1981, Marriott Hotel, Santa Clara, CA

- Silicon as a Mechanical Material, Dr. Kurt Petersen, IBM Corporation, San Jose, CA
 - “Silicon as a Mechanical Material,” published in the *IEEE Proceedings* in May 1982 (3795 citations as of Sep. 2017)
 - “Father of MEM Systems”
 - Co-Founded Cepheid (1996)

Speakers Through the Decades

10th EMS 1982, Marriott Hotel, Santa Clara, CA

- Future Direction in the Electronics Industry, Prof. Carver Mead, Caltech, Pasadena, CA (3)

11th EMS 1983, Marriott Hotel, Santa Clara, CA

- Getting Out of the Recession, Mr. Don Hoeffler, Microelectronics News, Pacific Grove, CA
 - First to use the term “Silicon Valley” (*Silicon Valley in the USA*, Electronic News, 1971)
- VLSI Analytical Technique Overview, Dr. Noel MacDonald, Perkin-Elmer, Norwalk, CT
 - Pioneering work in scanning auger spectroscopy
 - Principle dissertation adviser

13th EMS 1985, Marriott Hotel, Santa Clara, CA

- Heterostructures for Everything: The Future of Compound Semiconductor Devices?, Prof. Herbert Kroemer, UCSB, CA
 - 2000 Nobel Prize in Physics (with Kilby) "for developing semiconductor heterostructures used in high-speed and opto-electronics"
- High Resolution Microscopic Studies of VLSI Interfaces, Prof. John C. Bravman, Stanford University, Stanford, CA
 - 17th President of Bucknell University

14th EMS 1986, Marriott Hotel, Santa Clara, CA

- Scanning Tunneling Microscopy, Dr. Shirley Chiang, IBM Almaden Research Center, San Jose, CA
 - 1st female EMS speaker

16th EMS 1988, Marriott Hotel, Santa Clara, CA

- Learning in Neural Networks, Prof. David Rumelhart, Stanford University, Stanford, CA
 - 88th most cited psychologist of the 20th century
- Wafer Scale Integration/Packaging, Prof. Fabian Pease, Stanford University, Stanford, CA
- Nanofabrication, Prof. Edward Wolf, Cornell University, Ithaca, NY (2)

Speakers Through the Decades

17th EMS 1989, Marriott Hotel, Santa Clara, CA

- Compound Semiconductor Materials for Visible Emitters, Dr. M. George Craford, Hewlett-Packard, San Jose, CA
 - Invented the first yellow, red, and red-orange LED (1972)

18th 1990, Marriott Hotel, Santa Clara, CA

- Nanoelectronics: Problems and Promises, Dr. John Randall, Texas Instruments, Dallas, TX
- Recent Advances in Resist Materials, Dr. C. Grant Willson, IBM Research, San Jose, CA
 - Pioneer in photoresist research
- Voyager: Grand Tour of the Solar System, Dr. David Morrison, NASA Ames Research Center, Moffett Field, CA
 - First quantitative estimate of the cosmic impact hazard (1994)
 - University of Hawaii Vice Chancellor for Research and Director of the 3-meter NASA Infrared Telescope Facility of Mauna Kea Observatory responsible for several planetary discoveries (1969 – 1980)
 - Founder of the multi-disciplinary field of astrobiology (2001)
- Reliable Gate Dielectrics for Future VLSI, Prof. Chenming Hu, U.C. Berkeley, Berkeley, CA
 - “Microelectronics visionary ... whose seminal work on metal-oxide semiconductor (MOS) reliability and device modeling has had enormous impact on the continued scaling of electronic device,” IEEE 2009

20th EMS 1992, La Barron Hotel, San Jose, CA

- Advanced X-Ray Optics for Soft X-Ray Projection Lithography, Dr. Andrew Hawryluk, LLNL, Livermore, CA
 - CRADA between three national labs and eight US companies to develop Soft X-ray Projection Lithography (SXPL) (1991)
 - SXPL becomes Extreme Ultraviolet Lithography (EUVL) in 1993

21th EMS 1993, La Barron Hotel, San Jose, CA

- Advanced Non-Linear Optical Materials: From the Laboratory to the Marketplace, Prof. Robert Byer, Stanford University, Stanford, CA
 - Lead Stanford University's contributions to the Laser Interferometer Gravitational Wave Observatory, which made the first-ever detection of a disturbance in space-time caused by a pair of merging black holes on September 14, 2015

Speakers Through the Decades

23th EMS 1995, La Barron Hotel, San Jose, CA

- Materials and Technology for Micro-Electro-Mechanical Systems, Prof. Richard Muller, U.C. Berkeley, Berkeley, CA
 - Proposed Nemesis hypothesis suggesting the Sun could have an as yet undetected companion dwarf star, whose perturbations of the Oort cloud and subsequent effects on the flux of comets entering the inner Solar System could explain an apparent 26 million year periodicity in extinction events (1988)
 - A founder and board member of the Berkeley Earth Surface Temperature ("BEST") project, which published an independent analysis of the Earth's surface temperature records (2010)
 - "Top 100 Global Thinkers" for "for changing their minds" about climate change (*Foreign Policy* 2012)
- CVD Cu and Al Metallization Films, Prof. Alain Kaloyeros, SUNY, Albany, NY
 - Founding President and Chief Executive Officer of the SUNY Polytechnic Institute (1966)
 - Currently suspended without pay from all positions within SUNY following federal and state indictment on felony bid-rigging charges

25th EMS 1997, Sunnyvale Hilton, Sunnyvale, CA

- Magnetic Tunnel Junctions, Science and Technology, Dr. Stuart Parkin, IBM, San Jose, CA
 - 2014 Winner of the Millennium Technology Prize "in recognition of his discoveries, which have enabled a thousand-fold increase in the storage capacity of magnetic disk drives"
 - Elected a Fellow of the Royal Society of Edinburgh, Scotland's national academy of science and letters (2016)

26th EMS 1998, Sunnyvale Hilton, Sunnyvale, CA

- Trends in Integrated Electronic Technology II, Dr. Gordon Moore, Intel, Santa Clara, CA

28th EMS 2000, Sunnyvale Hilton, Sunnyvale, CA

- Molecular Nanotechnology: Economically Making and Interconnecting Molecular Switches, Dr. Ralph Merkle, Zyvex, Richardson, TX
 - Devised Merkle's Puzzles, a scheme for communication over an insecure channel, and is now recognized to be an early example of public key cryptography (1974), co-invented the Merkle–Hellman knapsack cryptosystem (1978), invented cryptographic hashing and invented Merkle trees (1979)

Speakers Through the Decades

29th EMS 2001, Sunnyvale Sheraton, Sunnyvale, CA

- Electron Spin Resonance Transistors, for Quantum Communication & Computing, Dr. Eli Yablonovitch, UCLA, CA
 - Co-Founded (Father of ...) the field of photonic crystals (1987)
 - First to recognize that a strained quantum-well laser has a significantly reduced threshold current compared to its unstrained counterpart (1987)
 - "Inhibited Spontaneous Emission in Solid-State Physics and Electronics" among the most highly cited paper in Physics and Engineering (1987)
 - First to create a 3-dimensional structure that exhibited a full photonic bandgap, named Yablonovite (1991)

30th EMS 2002, Sunnyvale Sheraton, Sunnyvale, CA

- Surface and Microanalysis of Electronic Materials, Dr. Charles Evans, Charles Evans & Assoc., Sunnyvale, CA
 - Founded Charles Evans & Associates (later Evans Analytical Group or EAG) (1978)
- MEMS for Bio-Threat Detection?, Dr. Kurt Petersen, Cepheid, Sunnyvale, CA (2)
- Nanoparticle Electronics and Photonics, Prof. Harry Atwater, Caltech, Pasadena, CA
 - Created new photovoltaic devices, including the silicon wire array solar cell, and layer-transferred fabrication approaches to III-V semiconductor III-V and multijunction cells, as well as making advances in plasmonic light absorber structures for III-V compound and silicon thin films

31th EMS 2003, Techmart Meeting Center, Santa Clara, CA

- Perspectives on Nanosciences and Nanotechnology, Prof. Mildred Dresselhaus, MIT, Cambridge, MA
 - "Queen of Carbon Science"
 - First female Institute Professor and Professor Emerita of Physics and Electrical Engineering at MIT (1985)
 - Presidential Medal of Freedom (2014)

Speakers Through the Decades

32th EMS 2004, Techmart Meeting Center, Santa Clara, CA

- The Power of the Very Small: Nanoscience Innovation at the California NanoSystems Institute, Prof. Evelyn Hu, UCSB, CA
 - Seminal work in nanofabrication including high-resolution patterning and high-resolution etching of circuits onto nanoscale materials

33th EMS 2005, Techmart Meeting Center, Santa Clara, CA

- LEDs for Solid State Lighting: Technology, Applications, and the Remaining Challenges, Dr. George Craford, Lumileds, Netherlands (2)

34th EMS 2006, Techmart Meeting Center, Santa Clara, CA

- Approaching the 29% Efficiency Limit of Silicon Solar Cells, Dr. Richard Swanson, SunPower, San Jose, CA
 - Founded SunPower (1995)
 - Credited with Swanson's Law: the Moore's Law for the solar panel industry (2012)
 - "Father of solar power in the US"
- Semiconductor Nanowires, Prof. Peidong Yang, U.C. Berkeley, Berkeley, CA
 - Ranked as the top materials scientist and among the top 10 chemists of the decade 2000-2010 in 2010 by Thomson Reuters

36th EMS 2008, Techmart Meeting Center, Santa Clara, CA

- Imaging Charge Transport, Prof. Nancy Haegel, Naval Postgraduate School, Monterey, CA
- Surface Engineering of MEMS, Prof. Roya Maboudian, U.C. Berkeley, Berkeley, CA
- Giant Magneto Resistance, Dr. Stuart Parkin IBM, San Jose, CA (2)

37th EMS 2009, Techmart Meeting Center, Santa Clara, CA

- Resolving Sub-nm Steps with a Low-Voltage Miniature Scanning Electron Microscope, Dr. Lawrence Muray, Novex Inc., Lafayette, CA

40th EMS 2012, Agilent Technologies, Santa Clara, CA

- Whatever Happened To (Name Your Device or Technology Here)?, Prof. Fabian Pease, Stanford University, Stanford, CA (3)

Speakers Through the Decades

41th EMS 2013, Techmart Meeting Center, Santa Clara, CA

- Building Computers with Bacteriophage, Prof. Drew Endy, Stanford University, Stanford, CA
 - “Synthetic biology’s most compelling evangelist” as he is persistent on discussing the prospects and dangers of synthetic biology on nearly any forum (Michael Specter, 2009)
 - Created the biological equivalent of a transistor, dubbed a transcriptor (2013)
- Living in Space; Six and a Half Months on the International Space Station, Prof. Daniel W. Bursch, NPS, Monterey, CA
 - 196-day mission set a new record (simultaneously set with crew mate Carl Walz) for the longest duration spaceflight for an American astronaut (2002) (215-day record set in 2010)

42th EMS 2014, Agilent Technologies, Santa Clara, CA

- Plasmonics for High Temperature Applications, Prof. Vlad Shaleav, Purdue University, West Lafayette, IN
 - “Recognized for his pioneering studies on linear and nonlinear optics of random nanophotonic composites that had helped to mold the research area of composite optical media” Lamb Award (2010)

43th EMS 2015, Agilent Technologies, Santa Clara, CA

- How To Start A Company without Betting The Farm, Milton Chang, Incubic, Palo Alto, Ca
 - Founded New Focus (1992) and Incubit Ventures (2012)
 - Author of *Toward Entrepreneurship* (2011)
- Revolutionizing Materials Innovation through the Materials Genome Project, Prof. Gerbrand Ceder, U.C. Berkeley, Berkeley, CA
 - Elected to the National Academy of Engineering, “For the development of practical computational materials design and its application to the improvement of energy storage technology” (2017)

46th Electronic Materials Symposium 2018

- Label-free isolation of cells using magnetic levitation, Dr. Andreja Jovic, Levitas Bio
- Quantitative biology with droplet microfluidics, Prof. Adam Abate, UCSF
- Digital atomic scale fabrication, Dr. John Randall, Zyvex Labs
- Quantum information and a Michelson-Morley test with electrons, Prof. Hartmut Haeffner, U.C. Berkeley
- Gene editing: past present and future, Dr. Kathryn Loving, Caribou Biosciences
- Recent advances in neural dust: towards a neural interface platform, Prof. Michel Mararbiz, U.C. Berkeley
- A guided safari through the properties of over 1000 2D materials revealed by data mining techniques, Prof. Evan Reed, Stanford University
- Atom-by-atom characterization of nanomaterials with STEM tomography, Prof. Mary Scott, U.C. Berkeley

