

The Thirty-Sixth Annual Ross Tucker Award Recipients

Pratik Patel

Department of Electrical Engineering and Computer Science, University of California, Berkeley
Thesis Advisor: Prof. Chenming Hu

The Stanford award is to be presented at the symposium

The First Annual EMS Student Poster Award Recipient

TBD at Symposium

The First Annual NPS Ralph Krause Award Recipient

TBD at Symposium

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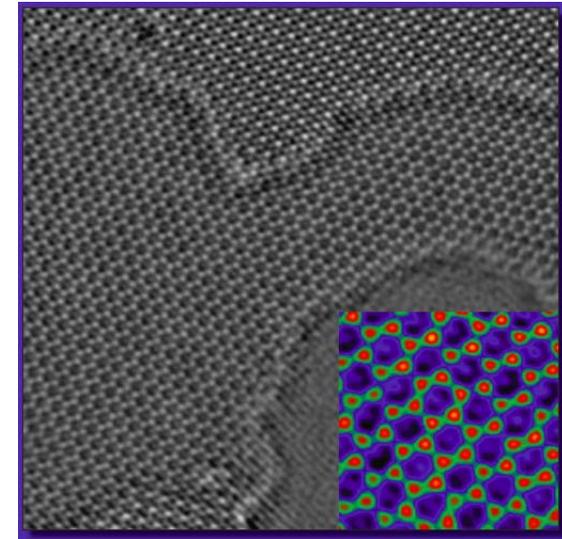
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The organizing committee would like to thank Greg Brown for webmastering

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The 38th Annual ELECTRONIC MATERIALS SYMPOSIUM

A One-Day Symposium on Electronic Materials
Featuring Authorities Outstanding in their Fields

Network Meeting Center at Techmart
5201 Great America Parkway

Santa Clara, California
Friday, April 16, 2010

PROGRAM

Friday, April 16, 2010
Network Meeting Center at Techmart, Santa Clara

8:00	Registration	12:15	LUNCHEON
MORNING SESSION		AFTERNOON SESSION	
Session Chair:	Dr. Larry Muray Agilent	Session Chair:	Dr. Jeff Urban UCB
8:30	Welcome Remarks and Introduction Prof. Todd Weatherford, Naval Postgraduate School	1:05	Luncheon presentation: “The IEEE at 126” Dr. Lewis Terman, IBM
8:35	<i>“The Landscape of Photovoltaics- How Today’s Mature Technologies Enable Tomorrow’s Energy Security”</i> , Dr. Markus Beck, First Solar	2:15	<i>“Advanced STEM research: Atomic-scale Characterization of Applied Nanostructures”</i> , Dr. Joerg Jinschek, FEI Company, Europe Nanoport, Eindhoven, NL
9:20	<i>“A New Generation of X-ray Lasers for Science and Technology”</i> , Prof. Roger Falcone, UC Berkeley/LBNL	3:00	<i>“Nanopatterned Magnetic Recording Media”</i> , Dr. Thomas Albrecht, Hitachi Global Storage Tech., San Jose Research Center
10:05	Posters & Refreshments (Morgan Hill Room)	3:45	Posters and Refreshments (Morgan Hill Room)
10:45	<i>“Catalysts – Key Materials for Producing Fuels and Chemicals”</i> , Prof. Alexis Bell, UC Berkeley Dept of Chemical Engineering	4:30	Awards Presentations – Dr. Terman to award 34th Ross Tucker Award 1st EMS Student Poster Award 1st Ralph Krause Award
11:30	<i>“Precision Measurement in Biology”</i> , Prof. Steven Quake, Stanford Dept of Bioengineering	5:00	Closing remarks , Dr. Ning Cheng, Altera, 2011 EMS Chair
		6:00	Committee/Vendor/Speaker Dinner location – Pedro’s, Santa Clara

About the Cover:

The cover shows an exit-wave phase image of graphene (single and double atomic sheets). Inset shows a magnified image of atomic arrangement in a single graphene sheet. Images were acquired on a FEI Titan G2 60-300, taken at 80 kV using an image spherical aberration (Cs) corrector and a monochromated XFEG electron gun with energy spread of about 0.2 eV. * Cover image used with permission from Dr. Joerg Jinschek of FEI

General Information: The registration covers admission to the symposium sessions, abstracts of the symposium presentations, luncheon, a vendor’s exhibit, and the poster session. The Electronic Materials Symposium Committee exists to promote the understanding of electronic materials within the industrial and academic communities of the San Francisco Bay area. This committee organizes the annual Electronic Materials Symposium, featuring presentations on advanced electronic, magnetic and optical materials processing, characterization and devices by outstanding speakers who have made significant contributions to their fields. Proceeds of the symposium are used to support electronic materials research and education in local universities.

ELECTRONIC MATERIALS SYMPOSIUM

LIST OF VENDOR PARTICIPANTS

We would like to give special thanks to this year’s vendors who provided the opportunity for many students to attend this conference through registration scholarships. Please take the time to stop by and visit the vendors’ booths during the poster session breaks and luncheon break.

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IEEE SCV Section

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EMS Student Posters

“Growth of textured polycrystalline Ge thin films on glass substrates for photovoltaics”, Shu Hu, P. C. McIntyre, *Dept. of Materials Science & Engineering, Geballe Lab. for Adv. Mat., Stanford University*

“Influence of aluminum microstructure on aluminum induced crystallization (AIC) of sputtered amorphous silicon thin film”, Amirhossein Khalajhedayati, E. Allen, *Chemical and Materials Engineering Dept., San Jose State University*

“Strain relaxation mechanisms in compressively-strained SiGe-on-insulator (SGOI) films grown by Si selective oxidation” Marika Gunji, A. F. Marshall, and P. C. McIntyre *Dept. of Materials Science and Engineering, Geballe Lab. for Adv. Mat., Stanford University*

“Electrical, electrothermal, and optical properties of n- and p-type InN”, Nate Miller, J.W. Ager, H. M. Smith, M. A. Mayer, K. M. Yu, M. E. Hawkrige, E. E. Haller, W. Walukiewicz, W. J. Schaff, C. Gallinat, G. Koblmuller, and J. S. Speck, *LBNL, Dept. of Materials Science and Engineering, UC Berkeley, Dept. of ECE, Cornell University, Materials Dept., UC Santa Barbara*

“Manipulating the Easy Axis in Ga_{1-x}Mn_xP: Magnetic Anisotropy in an Insulating Ferromagnetic Semiconductor” Peter R. Stone, C. Bihler, L. Dreher, J. W. Beeman, K. M. Yu, M. S. Brandt, O. D. Dubon *Dept. of Materials Science & Engineering, UC Berkeley, LBNL, Walter Schottky Institut, Technische Universität München, Germany*

“Domain Wall Injection in Racetrack Memory” Timothy Phung, *Stanford University*

“Nano-composite metal/TiO₂/Si anodes for water oxidation” Yi Wei Chen, J. Prange, S. Duehnen, B. Shin, Y. Park, M. Shandalov, C. E. Chidsey, and P. C. McIntyre, *Dept. of Materials Science & Engineering, Stanford University, Dept. of Chemistry, Stanford University*

“Imaging Charge Transport in Nanowires with Near Field Scanning Microscopy” R. Adam Cole, L. Baird and N. M. Haegel, *Physics Dept., Naval Postgraduate School, Monterey*

“In situ TEM study of electrical switching in lateral phase-change memory cells” Stefan Meister, J. Cha, Y. Cui, *Dept. of Materials Science and Engineering, Stanford University*

“Fabrication of MEMS-based Directional Sound Sensor on SOI Substrate”, Michael Touse, J. Sinibaldi and G. Karunasiri *Dept. of Physics, Naval Postgraduate School, Monterey*

“Cathodoluminescent Lighting Based on Carbon Nanotube Field Emitters” Jovita Tjahjadi, B. Ribaya, J. Silan, D. Niemann, S. Yim, E. Allen, C. V. Nguyen, *San Jose State University, NASA Ames Research Center*

“Science-based modeling of carbon nanotube ultracapacitor” Antonis Orphanou, T. Yamada, and C. Y. Yang, *Center for Nanostructures, Santa Clara University*

“Design of high-absorption Terahertz films” Christos Bolakis, D. Grbovic, and G. Karunasiri *Dept. of Physics, Naval Postgraduate School, Monterey*

“A Terahertz Reverse Micromagnetron”, Michael Aiena, M. Güner, and A. Larraza, *Dept. of Physics, Naval Postgraduate School, Monterey*

The Landscape of Photovoltaics – How Today’s Mature Technologies Enable Tomorrow’s Energy Security

*Dr. Markus Beck
First Solar*

During the 70’s and 80’s photovoltaics (PV) was in its infancy and by 1990 the worldwide production of PV still hadn’t reached the 50MW/year level. The turn of the millennium brought heightened awareness of the state of the planet as well as a novel concept of supporting the establishment of a renewable energy industry. The latter was led by Germany and its feed-in tariff approach (FIT); as a result the demand for PV skyrocketed virtually overnight. In 2000 global PV manufacturing volume had reached just under 300MW as the industry transitioned into adolescence. By 2004 the 1GW/y barrier was broken for the first time and the term ‘industry’ started to become applicable to the PV sector. Annual growth rates in excess of 40%, slightly quenched by the financial crisis in 2008, saw 2.5GW/y in 2006 and almost 6GW/y in 2008 for a cumulative global installed PV base of 13.4GW. 2009 added another 6.4GW and with new emerging markets the growth projections continue to be optimistic.

This presentation will focus on the key PV technologies, namely flat plate PV modules based on (multi)crystalline Si and thin film (TF) CdTe as well as CIGS, having contributed to the success and offer an outlook into the near future. Furthermore, the key market segments will be reviewed by application – free field, commercial rooftop, residential rooftop, and off-grid/consumer products – as well as regional install and manufacturing base. Furthermore, the contribution of PV to today’s energy production will be put into perspective versus the renewable energy sector as well as total global electricity generation.

Dr. Markus E. Beck, draws on over 15 years of experience in thin film (TF), solid state, compound semiconductor photovoltaic (PV) R&D as well as manufacturing. Before joining industry in 2001 as the senior scientist leading process development at Global Solar Energy (GSE) a pioneer in manufacturing of copper indium gallium diselenide (CIGS) based PV on flexible substrates, he worked as a research scientist on fundamental TF PV material processing and properties at both the National Renewable Energy Laboratory (Golden, CO), as well as the Hahn-Meitner Institute (Berlin, Germany).

Upon developing and optimizing the TF material processes at GSE, Dr. Beck’s focus shifted to product design and reliability testing for flexible, portable PV products as well as standard power PV modules. Besides contributing to the commercial success of GSE, the first US company to commercially produce CIGS-based PV, the GSE team effort was honored with a R&D 100 award in 2004 citing 4 key researchers at GSE; one of whom is Dr. Beck. In January of 2006 Dr. Beck joined the team founding Solyndra Inc., subsequently in the summer of 2008 to become only the 2nd US-based company entering commercial production of CIGS-based PV. In his role as CTO he was responsible for aspects spanning from process development and metrology, material and device characterization, as well as product design and reliability.

As of fall 2008 Dr. Beck joined First Solar, the world’s largest module manufacturer, where his key focus is on disruptive new technologies. Dr. Beck holds a PhD in physical chemistry from the University of Guelph, (Ontario, Canada) pioneering a novel method synthesizing CIS in a non-vacuum process from amorph oxide precursors. As an expert member in the US TAG he is also actively engaged in drafting and maintaining international standards for PV modules under IEC TC82 WG2. Over the past years Dr. Beck has also served on numerous DOE subject matter expert panels reviewing diverse PV R&D and manufacturing grant applications.

A New Generation of X-Ray Lasers for Science and Technology

*Prof. Roger Falcone
UC Berkeley/LBNL*

I will describe a new generation of powerful x-ray laser facilities that will address needs in basic science and technology, including the understanding of reaction dynamics at atto- and femtosecond time scales, and advanced materials development for sustainable energy technologies.

The x-ray laser is based on a superconducting, high current, GeV-scale, electron accelerator, and will produce multiple beams of fully coherent x-ray radiation. It follows on the recent demonstration of success of the LCLS x-ray laser at the SLAC National Accelerator Laboratory, which produces femtosecond pulses of x-rays for experiments ranging from atomic physics to materials under extreme conditions.

Professor Roger Falcone is Professor of Physics at the University of California, Berkeley, and Director of the Advanced Light Source Synchrotron and Associate Laboratory Director for Photon Sciences at Lawrence Berkeley National Laboratory.

He was born in New York City, received his AB in Physics from Princeton (1974), and his PhD in Electrical Engineering from Stanford (1979), where he was the Chodorow Fellow in Applied Physics before joining Berkeley in 1983. He chaired the Physics Department at Berkeley from 1995 -2000.

Falcone is a Fellow of the APS, OSA, and AAAS. He was awarded the Leo Szilard Lectureship Award (2005) of the American Physical Society along with the APS Study Group on Boost-Phase Intercept Systems for National Missile Defense, the Halbach Prize for Instrumentation (2000) at the ALS, LBNL with Robert Schoenlein, was a Distinguished Traveling Lecturer of the APS, Laser Science Topical Group (1992-93), and was a Presidential Young Investigator of the National Science Foundation (1984).

Falcone is the author of over 120 papers in his research fields of lasers, atomic and solid state physics, and ultrafast phenomena. He is a member of the Science and Technology Committee for Lawrence Livermore National Security and Los Alamos National Security. He chaired the Science Advisory Committee for the LINAC Coherent Light Source at the SLAC National Accelerator Laboratory. He has been director of the University of California Institute for Materials Dynamics at Extreme Conditions, and is Co-Faculty Director of California Teach at Berkeley, a program to train undergraduates majoring in science and math to become K-12 teachers. He chairs the faculty advisory committee to the Lawrence Hall of Science at Berkeley.

Falcone served for five years on the School Board of his hometown of Lafayette, CA, and is currently vice president of the Board of Trustees of the Lafayette Library and Learning Center Foundation, a group building a new community library with a consortium of Bay Area cultural organizations.

Nanopatterned Magnetic Recording Media

*Dr. Thomas R. Albrecht
Hitachi Global Storage
Technologies*

After years of rapid advances in electronics and information technology, researchers face new challenges due to the approach of various fundamental physical limits that may inhibit further device and bitcell miniaturization. In magnetic recording, the 50-year cumulative improvement of 10^8 in areal density may not be extendible beyond 1 Tbit/in² because of mutually exclusive requirements for thermal stability, writability, and signal-to-noise ratio, all related to scaling of the grain size in thin film magnetic media. Solving these problems may require adoption of either patterned media (PM) or energy-assisted writing.

There are two versions of PM: discrete track media (DTM), in which a conventional granular recording film is patterned into physically separated tracks, and bit patterned media (BPM), which is patterned into single-bit islands. While DTM does not significantly improve thermal stability, it may offer a modest increase in density via reduced adjacent track interference. BPM, in contrast, is significantly more difficult to fabricate due to smaller feature size, but offers the potential for substantial density gain by changing from multiple independent grains per bit to a single-domain thermally stable magnetic island per bit.

To fabricate PM, a master pattern is first generated by e-beam lithography. The small feature size (10–50 nm), tolerance requirements, and pattern extent drive the use of measures such as rotary-stage e-beam architecture, cold ultrasonic development, multiple exposure of features, and blankerless writing.

To go beyond the reach of e-beam, innovative self-assembly methods are being used, in which a chemical contrast pattern derived from an e-beam pattern provides dense guiding information for the self-assembly of block-copolymer domains with tightly controlled tolerances, and defect-free long-range order in circular track patterns. UV-cure nanoimprint lithography is used to replicate master patterns over large volumes of disks. Since PM only requires a single patterning step (no overlay), tools and process are greatly simplified compared to what is needed semiconductor device fabrication.

Successful recording on BPM (Fig. 2) requires high write field gradient and a tight distribution of island switching fields. Creation of magnetically uniform islands requires stringent control of magnetic anisotropy and moment, as well as island dimensions and placement tolerances.

Magnetic recording on BPM has achieved a density of 320 Gbit/in² (similar to that achieved by thermally-assisted writing on unpatterned media). The combination of BPM with thermal assist write head has demonstrated writing at 1 Tbit/in².

Dr. Thomas R. Albrecht received a B.A. in physics from Carleton College (Northfield, MN) in 1985 and a Ph.D. in applied physics from Stanford University in 1989. In his thesis research at Stanford, Tom created the first microfabricated cantilevers for the Atomic Force Microscope (AFM). From 1989 through 2004, he was employed at the IBM Almaden Research Center, working on data storage technologies in the areas of track-following servo, head-disk interface, load/unload, and IBM's 1-inch Microdrive. During 2002 and 2003 he was on assignment to the IBM Zurich Research Laboratory, where he managed the "Millipede" MEMS-based data storage project. In 2004, he joined Hitachi Global Storage Technologies to continue research on disk drive technology, specifically in the area of patterned media. Tom has 92 issued U.S. patents and 46 publications.

Advanced S/TEM research: atomic-scale characterization of applied nanostructures

Dr. Joerg R. Jinschek
FEI, Eindhoven, NL

Currently the strong focus on energy producing and environmental protecting technologies relies on the advancement of new functional nanomaterials. Inevitably, detailed atomic-scale insight into the geometrical, compositional and electronic structures of these nanomaterials is of paramount importance to establish a detailed understanding of the structure-performance relationships of the nanomaterials that eventually forms the basis for rational design of new, improved functional nanostructures.

With the recent advancements, scanning/transmission electron microscopy (S/TEM) has become a powerful and indispensable (in-situ) tool for characterizing nanomaterials with a spatial resolution in the sub-Angstrom range, with an spectral resolution in the sub-eV range, and with a sensitivity for detecting even single atoms. And now by implementing environmental cells (E-TEM), catalytic and environmental nanomaterials can be observed “at work” - time resolved at atomic resolution with single atom sensitivity.

Although these recent improvements in microscope performance offer bright research prospects they also include a set of new methodological challenges. My research is mainly focusing on methodological aspects of state-of-the-art electron microscopy.

For instance, it is very captivating to study the effect of aberrations and electron energy spreads on the image/probe forming process in S/TEM and the achievable resolution as well as sensitivity in order to fully exploit these methods in unraveling the atomic scale realm of functionalized (in)organic nanostructures and to further advance the limits for achievable information towards atomic resolution in full 3-D (electron tomography). The work includes examples for a variety of materials done in a collaborative approach with university groups and at industrial laboratories.

Dr. Joerg Jinschek was awarded his Diploma and his PhD in physics at the Friedrich-Schiller-University Jena / Germany in 1997 and in 2001, respectively, for microscopic and spectroscopic studies of thin films.

In 2001 he received the Feodor-Lynen-Fellowship of the Alexander-von-Humboldt-Foundation. He worked as a postdoctoral researcher at the National Center for Electron Microscopy (NCEM) in Berkeley, CA, and he performed advanced Scanning / Transmission Electron Microscopy studies on commercially available solid-state InGaN LEDs. He has also been working on a method to achieve single atom resolution in 3-D (electron tomography). In 2005 he joined the Materials Science Department and the Geosciences Department at Virginia Tech, Blacksburg, VA, to build up a new Electron Microscopy lab and to lead the S/TEM research effort on its campus. He joined FEI Company in Eindhoven, NL as a Senior Research Scientist in 2008. He is responsible for the scientific collaboration with the Center for Electron Nanoscopy (DTU, Denmark) that focuses on the application of state-of-the-art aberration-corrected electron microscopes. He is also working as FEI's application scientist for environmental-cell TEM (ETEM) to study in situ gas-solid reactions.

Catalysts – Key Materials for Producing Fuels and Chemicals

Prof. Alexis T. Bell
University of California, Berkeley

Virtually all chemical and energy conversion processes being practiced today are dependent on the availability of catalysts, materials that enable the needed chemical reactions to be carried out at economically attractive rates and with efficient utilization of reactants. Catalysts are also essential for the protection of the environment, and in particular vehicular emissions of exhaust gases into the atmosphere. Since the activity and selectivity of a catalyst derive from its composition and structure, its highly desirable to understand what factors determine these performance characteristics. This talk will show how advances in analytical techniques (e.g., TEM, EXAFS, XANES, and Raman and infrared spectroscopy) in combination with theoretical methods (e.g., quantum chemistry, statistical mechanics) are contributing to the development of a molecular-scale understanding of the relationships between catalyst composition/structure and catalyst activity/selectivity. It will also be shown that while catalysts cannot be designed from first-principles, the catalysis science can provide considerable guidance to the development of high-performance catalysts.

Alexis T. Bell received his Sc.D. degree from M.I.T. in Chemical Engineering in 1967. That same year he joined the Department of Chemical Engineering at the University of California at Berkeley in 1967, where he currently holds the title of Dow Professor of Sustainable Chemistry. From 1979-1981 he served as the Assistant Dean of the College of Chemistry, from 1981-1991 as the Chairman of the Department of Chemical Engineering, and from 1994-1999 as Dean of the College of Chemistry. Professor Bell is also a Faculty Senior Scientist in the E. O. Lawrence Berkeley National Laboratory.

Professor Bell is the Editor of *Catalysis Reviews and Chemical Engineering Science*, and he serves on the editorial board of a large number of other journals. He has also served on numerous committees of the American Chemical Society, the American Institute of Chemical Engineers, the Council for Chemical Research, and the National Research Council.

The results of his research have been published in over 550 articles appearing in refereed journals. He has received many honors for his research contributions. These include the Curtis W. McGraw Award for Research, given by the American Association of Engineering Education; the Professional Progress, R. H. Wilhelm, and William H. Walker Awards, given by the American Institute of Chemical Engineers; the Paul H. Emmett Award in Fundamental Catalysis and the Robert Burwell Lectureship, given by the North American Catalysis Society; ACS Award for Creative Research in Homogeneous or Heterogeneous Catalysis; Michel Boudart Award for the Advancement of Catalysis, given by the North American Catalysis Society and the European Federation of Catalysis Societies; and the Giuseppe Paravanno Award for Excellence in Research in Catalysis, given by the Michigan Catalysis Society. He is a member of the National Academy of Engineering, a Fellow of the American Association for the Advancement of Science, a Fellow of the American Academy of Arts and Sciences, and has received an honorary professorship from the Siberian Branch of the Russian Academy of Sciences. He has also presented eleven named lectures at various universities and research institutes.

Professor Bell is known for his research in the field of heterogeneous catalysis and is recognized as one of the leaders in applying *in situ* spectroscopic techniques in combination with isotopic tracer techniques to the study of catalyzed reactions. Of particular note have been his investigations of the mechanism of Fischer-Tropsch synthesis, the synthesis of methanol, the selective catalytic reduction of NO, the oxidative dehydrogenation of alkanes, and the direct conversion of methane to oxygenates. This work has led to an identification of the elementary steps affecting catalyst activity and selectivity, and their relationship to catalyst structure. He has also been engaged in understanding the connections between catalyst synthesis and structure. His work has revealed the role of structure-directing organic cations on the synthesis of zeolites and the effects of synthesis conditions on the structure of supported metal oxides. He has been involved, as well, in the development and application of theoretical techniques for predicting the dynamics of surface reactions on metals, and the adsorption, diffusion, and reaction of molecules in zeolites. This work is providing a basis for understanding the relationships between catalyst structure and the dynamics of elementary processes at a fundamental level.

Precision Measurement in Biology

*Prof. Steven Quake
Stanford*

Is biology a quantitative science like physics? Prof. Quake will discuss the role of precision measurement in both physics and biology, and argue that in fact both fields can be tied together by the use and consequences of precision measurement.

The elementary quanta of biology are twofold: the macromolecule and the cell. Cells are the fundamental unit of life, and macromolecules are the fundamental elements of the cell. I will describe how precision measurements have been used to explore the basic properties of these quanta, and more generally how the quest for higher precision almost inevitably leads to the development of new technologies, which in turn catalyze further scientific discovery. In the 21st century, there are no remaining experimental barriers to biology becoming a truly quantitative and mathematical science.

Stephen Quake invented the biological equivalent of the integrated circuit. He and his students developed the first microfluidic large scale integration (LSI) by fabricating chips with thousands of mechanical valves. This technology paved the way for large scale automation of biology at the nanoliter scale, and in recent years Quake and his collaborators have used it for applications as diverse as discovering a new drug for hepatitis C, mapping the genomes of unculturable environmental microbes, and measuring gene expression in individual cancer stem cells.

Prof. Steven Quake's group was the first to apply microfluidic technology to the determination of protein structure through x-ray crystallography. By showing that the unique fluid physics of nanoliter scale reactors allow one to control and manipulate the kinetics of protein growth in ways that are impossible at the macroscale, they developed a chip to screen protein crystal growth conditions that outperforms conventional methods by an impressive margin. This chip has been commercialized and is used in structural biology labs in industry and academia around the world.

Quake used microfluidic plumbing to create combinatoric arrays of assays that give unique economies of scale in labor and reagent consumption; these dynamic arrays have also been commercialized and are used by major pharmaceutical companies and research organizations for applications ranging from managing salmon fisheries to studying cancer.

Quake also demonstrated the first successful single molecule DNA sequencing technology, which has been commercially developed and is a leading candidate to deliver the first \$1,000 genome. In 2009 he and two co-workers sequenced his genome using the commercial version of the single molecule sequencing technology that he developed, an event that was widely reported in the popular press. He is one of the first half dozen people to have their entire genome sequenced and the only one to also have invented the sequencer used to obtain their genome.

His contributions to genomics also include the development of the first non-invasive prenatal test for Down syndrome, which was enabled by next generation sequencing technologies, and the first measurement of the immune repertoire of an organism.

The IEEE and 126

*Dr. Lewis Terman
IBM & past IEEE President*

In 2009 the IEEE celebrated its 125th anniversary, which dates from the founding of one of its predecessor societies, the American Institute of Electrical Engineers in 1884. In the subsequent years, the growth of IEEE has both contributed to, and mirrored, the ever increasing importance to the world of electricity, electronics, computer science, and the emerging myriad of related technologies.

IEEE is now the world's largest technical professional society, dedicated to the advancement of technology for the benefit of humanity, with almost 400,000 members in over 150 countries. The IEEE has been an integral part to progress of technology, which has penetrated into virtually every aspect of modern life around the world.

This talk will trace the advance of the IEEE and its related technologies over the past 125 years, review where we are today, and then make some projections to the future.

Dr. Lewis Terman received the B.S., M. S., and Ph. D degrees from Stanford University in 1956, 1958, and 1961 respectively. He joined the IBM Research Division in 1961, and retired in 2006 after a career of 45 years + 1 day. In 1964 he began working on semiconductor memory, becoming one of its earliest advocates, and participating in the program that resulted in the first IBM MOS memory products. He continued in the Research Division for over three decades, working on and managing groups in advanced semiconductor devices and technology, and chip, circuit and high speed processor design. In 2001 - 2003, he left the Research Division to serve as President of the IBM Academy of Technology, an IBM internal organization modeled after the US National Academies of Science and Engineering.

He returned to the IBM Research Division in 2003 as Associate Director of the Systems Department until retirement. At IBM, he received 9 IBM major technical awards, including 3 Corporate Awards.

Dr. Terman was the IEEE 2008 President. He was president of the IEEE Electron Devices Society 1990-91, and the IEEE Solid-State Circuits Society from 1998-1999. He was the IEEE Vice President of Technical Activities in 2001, and Division 1 Director 2004-2005. He is a Fellow of the IEEE, received the IEEE Solid-State Circuits Technical Field Award in 1995, and is a member of the US National Academy of Engineering.