

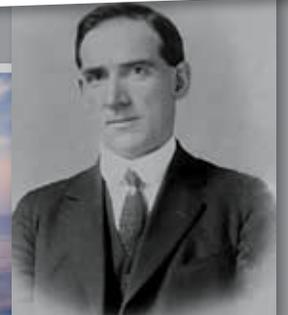
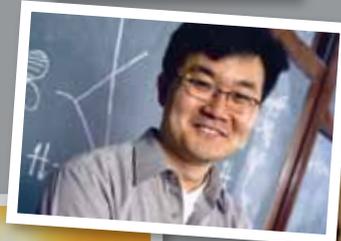
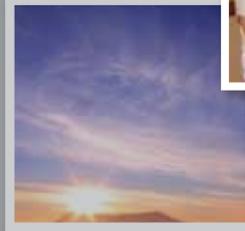


RESEARCH CORPORATION
for SCIENCE ADVANCEMENT

A foundation dedicated to science since 1912.

2010 annual report

investing in the future



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In 2010 RCSA launched a bold new experiment. Scialog® (science+dialog) accelerates the work of 21st-century transformational science through research, dialog and community.



James M. Gentile, President and CEO, leading a discussion on solar energy at Scialog 2010.



James M. Gentile

President's View: Building Communities in Science

In 2010, RCSA launched a dynamic new approach to accelerating science advancement.

Today the word “community” is broad and malleable, covering our towns and cities, neighborhood associations, interest groups and many other permutations. The word stems from Latin roots meaning “together” and “gift.”

One overarching community that took on form and focus in the 19th century has done much to enrich our lives—the community of scientists. And for nearly half of the time that the word “science” has come to be widely applied to the disciplined study of the natural world, Research Corporation for Science Advancement (RCSA) has been building and supporting that community.

Almost since its inception in 1912, RCSA has nurtured and tended to the community of American scientists in particular, consistently supporting a healthy proportion of the nation's high-risk/potentially high-reward theoretical work and experimentation, much of which today constitutes the fundamentals of global scientific knowledge.

Today, a mere year from its centennial, as RCSA continues to fund efforts at the very edges of human knowledge, we face numerous looming challenges, including global climate change, emerging diseases, rising energy demands, dwindling petroleum reserves, and increasing food and water needs—for which we naturally turn to science for solutions. These challenges seem doubly daunting, and the need for solutions increasingly urgent, against the background of rapid global population growth—6.8 billion today, to a projected 10 billion in just over three decades, with most of that growth occurring in the developing world.

The need for breakthrough science, always great, has never been greater; and to achieve those breakthroughs, we must, as ever, rely to a great extent upon community effort.

At RCSA we believe the time has come to attempt to improve upon the process of community building in science as a means of accelerating the “gifts” of insight and understanding that scientists bestow upon one another and, subsequently, upon society in general in the form of increasingly effective technologies. Thus 2010, the 98th year of RCSA's existence as American's second-oldest independent foundation, saw the launch of a bold new experiment in accelerating transformational science, of which community building is a part.

Scialog is all about bringing together accomplished, early career theorists and researchers—the most creative cohort in science—

JAMES M. GENTILE 2010 PUBLICATIONS

James M. Gentile, Ph.D., is President of Research Corporation for Science Advancement, a foundation dedicated to science since 1912 and the second-oldest foundation in the United States (after the Carnegie Corporation). Research Corporation for Science Advancement is a leading advocate for the sciences and a long-time funder of scientific innovation and of research in America's colleges and universities. Dr. Gentile is a tireless advocate for RCSA's vision, writing frequently on the importance of supporting early career scientists, interdisciplinary research, the integration of teaching and research, and high-risk research that can lead to transformations. Examples from 2010 include:

CHRONICLE OF HIGHER EDUCATION

June 6, 2010

[Let's Encourage Research Daring Enough to Fail](#)

It is imperative that the United States develop more aggressive research programs in basic science and early career scientists are the most likely to produce the breakthroughs. The U.S. faces growing scientific competition from abroad. Humankind also faces major global challenges in the 21st century. Thus it is vital that we accelerate transformative research. Doing so requires a greater tolerance for “failure.” That term, however, does not mean wasting research dollars. Rather, it refers to taking additional risks on potentially transformative hypotheses. Even if these hypotheses are not confirmed, experimentation can result in additional useful knowledge. Federal and private sources should provide bold funding initiatives for those best suited for risky research, namely early career scientists.

SCIENCE

August 20, 2010

[Nurturing Young Scientists](#)

Universities must create frameworks to encourage interdisciplinary research and synergistic teaching by early career scientists. This will require fundamental cultural changes. Those include efforts to re-evaluate promotion and tenure policies to affirm and reward cross-boundary collaborations. Change also entails redefining what constitutes original and independent contributions to research agendas involving multiple partners. It also requires institutions to reward those who forge “robust interactions” among groups.

HUFFINGTON POST

December 14, 2010

[Increase Science Funding to Grow U.S. Jobs](#)

In the second half of the 20th century, well over 40 percent of U.S. prosperity was the result of scientific and technological advances. Thus, if Americans want jobs, science funding should be increased, not cut. Demagoguery against science funding is a potentially harmful political activity.

November 22, 2010

America Wants Jobs, and "Jobs" Means "Science"

The overriding message of the mid-term elections was that Americans want their jobs back. We've lost more than 8.4 million of them in the last five years. The key to jobs in America has been, and remains, science and technology. What America needs is a "Smart Grid" to evaluate proposed research expenditures for key innovation factors.

October 22, 2010

America Needs To Re-energize Our Scientific Culture

Speakers at RCSA's first-ever Scialog conference called for new approaches to solar energy research. In addition, however, we must greatly improve our national academic-based science culture. The goal: to better support early career researchers and their innovative ideas that lead to breakthrough discoveries. Furthermore, we must more tightly integrate research and undergraduate science education. Doing so will prepare the next generation of researchers to tackle difficult problems. Also, we must support interdisciplinary and collaborative approaches to research, so that America remains first and best at doing the impossible.

October 1, 2010

Storm Warnings for America's Competitiveness

Rising above the Gathering Storm, Revisited dramatically illuminates our nation's accelerating decay in the areas of basic research and science education. President Obama has set a new goal of recruiting 10,000 science, technology, engineering, and math (STEM) teachers over the next two years. However, the U.S. has a long way to go if it hopes to keep up with China and other rapidly developing scientific powers.

June 23, 2010

Learning from the Gulf Oil Spill Could Save Our Planet

President Obama received generally poor marks for his June 15th Oval Office speech on the oil spill in the Gulf of Mexico. Meanwhile, our nation spends nearly \$1 billion a day to import foreign oil, while China and other nations rapidly invest in clean energy jobs and industry. The United States needs focus and determination to encourage radically innovative thinking to address the energy situation. Government must play a much more aggressive role in fostering our nation's science and innovation.

June 9, 2010

Kavli Prize-Winner and the Future of Science in America

Roger Angel, of the University of Arizona, a recent winner of the Kavli Prize, has a longstanding relationship with Research Corporation for Science Advancement. The Foundation awarded him two grants within four years of receiving his doctorate. This fact underscores that support for early-career scientists is a crucial catalyst to later greatness. Dr. Angel is an innovative designer and builder of advanced telescope mirrors.

His career demonstrates that transformative research is crucial to American leadership in the sciences. Dr. Angel will be attending the first ever Scialog conference in Tucson. Scialog is built around the idea that dialog across disciplines should be encouraged as a means to accelerate transformative research.

May 24, 2010

Will Politics Trump Economic Progress?

Re-authorization of the America COMPETES Act was held up recently when it was alleged that National Science Foundation employees were viewing pornography on the job. While such activities are indefensible, this is the wrong reason to limit science funding. Reauthorization is vitally important because it will fund the Advanced Research Projects Agency-Energy (ARPA-E). This agency is part of the U.S. Department of Energy's innovative initiative to accelerate breakthrough science. We need this agency's work to meet growing energy needs through renewable sources.

May 4, 2010

Scientific Innovation Should Be Highly Prized

The use of challenges and prizes is important for science and, more broadly, for innovation. Prizes and challenges can be designed to achieve multiple purposes at once. *Exemplar prizes*, such as the Nobel Prize, define excellence; *Point solution prizes* aim to reward and spur development of solutions; *Exposition prizes* help identify and promote a broad range of promising ideas; *Network prizes* strengthen communities; *Participation prizes* create value during and after the competition; *Market stimulation prizes* try to establish the viability of a market. RCSA's Scialog program is designed to achieve all but the first objective.

April 19, 2010

Empowering the Planet—An Earth Day Overview

Caltech Professor Nate Lewis warns that the world will need roughly twice as much carbon-free power by 2050 as all the carbon-based power we have today. In those 40 years, the human population of the planet is projected to grow from 6.6 billion to roughly 10 billion. Solving the world's developing energy crisis is the most important thing we humans can achieve. So much of who we are and what we hope to become is dependent upon ensuring adequate sources of energy.

March 24, 2010

Transformative Research and the Fruit Fly

Decoding the fruit fly genome is a project that could easily have been ridiculed by current critics of basic science research. Nevertheless, it has led to an increased understanding that may ultimately lead to cures for widespread diseases. Whenever anyone makes fun of understanding the fruit fly, remember that researchers may be investigating a disease that you wish would be defeated.

March 8, 2010

Science Education: The Value of Undergraduate Research

Highly respected educational psychologist David Lopatto has written a book, *Science in Solution*. The book provides a clear direction for science education at the college level. In it Lopatto makes clear that engaging undergraduate students in scientific research pays dividends. Lopatto notes that benefits of undergraduate research include learning what it's like to be a scientist, gaining experience that will advance career opportunities, and obtaining specific skills such as critical-thinking. *Science in Solution* was published by RCSA.

February 8, 2010

Who Will Win the Race for Jobs in Renewable Energy?

When it comes to renewable energy innovation and equipment manufacturing, China is challenging the West. The outcome of this challenge will decide where millions of jobs go in the future. The U.S. still has the lead in science and technology. The recent creation of the Advanced Research Projects Agency-Energy (ARPA-E) represents a wise effort to maintain that lead. But we need to use our current advantage to create more jobs for Americans.

January 19, 2010

Jumpstarting Energy Independence

U.S. Energy Secretary Steven Chu recently announced that 69 early career scientists will receive a collective total of up to \$85 million in research funds. This is an effort to jumpstart America's efforts toward energy independence. Through this action, DOE is boldly recognizing that early career researchers have been responsible for much of our breakthrough science over the last century. We owe it to the next generation of Americans to help today's early career scientists build tomorrow's science and technology infrastructure.

January 13, 2010

President Obama's Leadership in Improving STEM Education

President Obama should be applauded for making the sciences and science teaching a high priority in his Administration. He has done this through key Cabinet and senior staff appointments, funding from the Recovery Act, and the "Educate to Innovate" campaign, among other initiatives. He also deserves praise for challenging the business, higher-education, and philanthropic communities to join him in this effort. All of us should re-evaluate what we can do in this regard. RCSA's annual Cottrell Scholar Awards support university research projects, some of which involve collaborations with, and outreach to, high school teachers and students. The Foundation also recently published *Science Teaching as a Profession: Why It Isn't, How It Could Be*. This book was written by noted education writer Sheila Tobias and veteran science teacher Anne Baffert. It addresses issues crucial to high-school science teachers.

and established experts/mentors. Together they are encouraged to examine and overcome potentially limiting assumptions. The program also provides start-up funding for newly formed teams of researchers, often from across disciplines, to strike out in bold new directions.

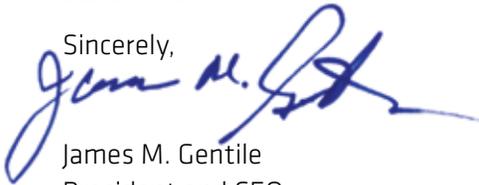
The goal is to produce breakthroughs collectively that have not yet been able to be produced individually.

Scialog is both a methodology and a grantsmaking program. In the spring of 2010, the Foundation made its first Scialog programmatic awards, following up with a fall convening of Fellows and mentors at Biosphere 2 outside of Tucson, Arizona. There the methodology was put to the test for the first time.

The results of that conference and the viability of the process of dialog employed there are still being analyzed. The experiment continues, as does RCSA's nearly 100-year mission of advancing the U.S. scientific enterprise.

We welcome your interest in our programs and methodology, and we look forward to your participation in, and support for, our efforts.

Sincerely,



James M. Gentile
President and CEO
Research Corporation for Science Advancement



James M. Gentile

2010 Success Stories

Ei-ichi Negishi is RCSA's 40th Nobel Laureate

In 2010 another member of the RCSA community, Ei-ichi Negishi, Distinguished Professor of Organic Chemistry at Purdue University, was added to the list of Nobel laureates. RCSA funded Negishi in the 1970s, when he was beginning his career. He received the Nobel Prize in Chemistry jointly with fellow American Richard F. Heck, and Japanese researcher Akira Suzuki, for groundbreaking work in palladium-catalyzed cross couplings in organic synthesis.

Research Corporation for Science Advancement has supported the work of thousands of scientists during the past 98 years, including the early work of at least 40 researchers who have gone on to receive Nobel Prizes.

Roger Angel Receives Kavli Prize

Roger Angel, University of Arizona Regents' Professor of Astronomy and Regents' Professor of Optical Sciences, and an RCSA early career grantee, was awarded the 2010 Kavli Prize in astrophysics along with Jerry Nelson and Ray Wilson. The Kavli Foundation awarded the prize to Angel and his colleagues "for their contributions to the development of giant telescopes" and the fundamental science that these enable.

Cherry Murray to Join RCSA Presidential Advisory Committee

Cherry A. Murray, Dean of Harvard University's School of Engineering and Applied Sciences, has agreed to join the RCSA Presidential Advisory Committee. Murray has led some of the nation's most brilliant scientists and engineers as an executive at Bell Laboratories and the Lawrence Livermore National Laboratory. She also holds the John A. and Elizabeth S. Armstrong Professorship of Engineering and Applied Sciences at Harvard. Murray's RCSA term becomes effective in 2011.

Lyman Page is 2010 Citation Laureate

Cottrell Scholar Lyman Page, Henry DeWolf Smyth Professor of Physics at Princeton University, has been chosen as a 2010 Citation Laureate and is predicted to win a Nobel Prize in Physics by Thomson Reuters. Page was a recipient of a Cottrell Scholar Award in 1994. He is an expert in observational cosmology and one of the original co-investigators for the Wilkinson Microwave Anisotropy Probe (WMAP) that has made the most precise observations yet of the cosmic background radiation, an electromagnetic echo of the Universe's Big Bang phase. Thomson Reuters predicts he will win the Nobel Prize for discoveries deriving from WMAP, including the age of the universe, its topography, and its composition.

Many of the following have received multiple RCSA grants over the course of their careers. However, only their first is listed. Although RCSA supports a wide variety of scientific endeavors, the Foundation wishes to stress its focus on supporting early career researchers.

2010 APS FELLOWS FUNDED BY RCSA

No more than one-half of one percent of the American Physical Society's current membership of 48,000 can be selected for inclusion in the APS Fellowship Program, created to recognize advances in knowledge through original research and publication, innovative contributions in physics and significant contributions to the teaching of physics.

David Bennett

University of Notre Dame; 1997 RCSA grant: A search for extra-solar planets via gravitational microlensing

Patrick Brady

University of Wisconsin, Milwaukee; 2002 RCSA grant: Towards the detection of gravitational waves from black hole binaries

Cynthia Cattell

University of Minnesota, Minneapolis; 1997 RCSA grant: A study of the effects of perturbations on energization and scattering of charged particles in a field-reversed magnetic field geometry

Michael Day

Lebanon Valley College; 1990 RCSA grant: Development and application of new theoretical methods to the S-4 model for magnetic systems (sponsored by the Whitaker Foundation)

Keith Dienes

University of Arizona; 2000 RCSA grant: New approaches for physics beyond the standard model

Stanley Haan

Calvin College; 1987 RCSA grant: Effects of continuum structure in photodetachment and recombination processes in atomic theory

Thomas Killian

Rice University; 2001 RCSA grant: Laser cooling and trapping an ultracold neutral plasma

Randall Knize

US Air Force Academy; 1997 RCSA grant: Production of cold trapped cesium molecules

Arshad Kudrolli

Clark University; 1998 RCSA grant: Experimental study of parametric correlations in an acoustic resonator

Luis Lehner

Louisiana State University, now at Perimeter Institute for Theoretical Physics, Ontario, Canada; 2003 RCSA grant: Black string simulations: Towards understanding their final fate

Anchang Shi

McMaster University; 2000 RCSA grant: Theory of self-assembly in block copolymer solutions

Jairo Sinova

Texas A&M University; 2006 RCSA grant: Spin-Hall effect in semiconductors and related phenomena in nano-spintronics

Ratnasingham Sooryakumar

Ohio State University; 1985 RCSA grant: Light scattering study of 2-D semiconductors;

David Van Baak

Calvin College; 1982 RCSA grant: Measurement of the hyperfine-structure splitting of the metastable state of atomic hydrogen

Martin Zanni

University of Wisconsin, Madison; 2002 RCSA grant: Protein solvation structures and dynamics studied with two-color 2D infrared spectroscopy

George Zimmerman

California Institute of Technology, now at Boston University; 1964 RCSA grant: Synthetic studies in strain free polycyclic systems

2010 ACS FELLOWS FUNDED BY RCSA

The American Chemical Society Fellows program began in 2009 to recognize and honor members for outstanding achievements in and contributions to science, the profession, and the Society. As of 2010, there were 355 ACS Fellows, out of a total ACS membership of 161,000.

Richard A. Bartsch

Washington State University, now at Texas Tech University; 1970 RCSA grant: Mechanistic studies of base-catalyzed beta-eliminations from syn- and anti-N-substituted benzaldimines

Jerry A. Bell

University of California, Riverside, now retired from American Chemical Society; 1963 RCSA grant: Decay kinetics following chemical activation

Theodore L. Brown

University of Illinois; 1958 RCSA grant: A study of metal halide addition compounds

Donald J. Burton

University of Iowa; 1963 RCSA grant: The addition of halogenated carbenes to fluorinated olefins

Norman C. Craig

University of Winnipeg, Oberlin College, emeritus; 1958 RCSA grant: Kinetics of thermal cis-trans isomerizations in the gas phase

William H. Daly

Louisiana State University; 1987 RCSA grant: Pharmacon racemate resolution with chiral polysulfone-g-polypeptide membranes (sponsored by the Exxon Education Foundation)

Anne M. Gaffney

Harvard University; 1982 RCSA grant: Surface chemical and photochemical studies of hydrocarbons adsorbed on group VIB transition metals

Nicholas E. Geacintov

New York University; 1970 RCSA grant: Investigation of effects of very high magnetic fields in physical-chemical and biophysical processes

Louis S. Hegedus

Colorado State University; 1973 RCSA grant: Transition-metal assisted functionalization of olefins

Rigoberto Hernandez

Georgia Institute of Technology; 1999 RCSA grant: Stochastic dynamics in irreversible non-equilibrium environments and computer-enhanced communication in the physical chemistry curriculum

K. W. Hipps

Washington State University; 1998 RCSA grant: Towards single molecule electronics

Timothy P. Lodge

University of Minnesota; 1982 RCSA grant: Diffusion of star-branched polymers in concentrated solutions of linear polymers by quasi elastic light scattering

Robert J. Madix

Stanford University; 1966 RCSA grant: Trapping sites in gas-solid collisions

E. Gerald Meyer

New Mexico Highlands University; 1954 RCSA grant: The exchange reaction between Tin (IV) and Tin (II) bromides in absolute alcohol and other solvents

Josef Michl

University of Utah; 1970 RCSA grant: Matrix-isolated new hydrocarbons via photoionization

C. Bradley Moore

University of California, Berkeley; 1995 RCSA grant: Chemical reaction dynamics

William F. Polik

Hope College; 1988 RCSA grant: Spectroscopy and dynamics of highly excited vibrational states in polyatomic molecules

Douglas J. Raber

National Academy of Science; University of South Florida; 1970 RCSA grant: The utility of oxonium salts as reagents and intermediates in organic synthesis

John E. Sheats

Rider University; 1992 RCSA grant: Synthesis and characterization of metallocene azo dyes (Sponsor: Bristol-Myers Squibb Company)

Herbert B. Silber

San Jose State University; 1988 RCSA grant: Lanthanide complexation reactions (Sponsor: Syntex Corporation)

Dennis W. Smith Jr.

Clemson University, now at the University of Texas, Dallas; 2001 RCSA grant: Synthesis and fabrication of novel fluoropolymers for photonic applications

2010 ACS NATIONAL AWARDS**Ei-ichi Negishi**

ACS Award for Creative Work in Synthetic Organic Chemistry, Syracuse University; 1973 RCSA grant: Chemistry of small ring organoboron compounds

Thomas J. Wenzel

ACS Award for Research at an Undergraduate Institution, sponsored by RCSA, Bates College; 1981 RCSA grant: Lanthanide ions as fluorescent probes in liquid chromatographic detection

Richard P. Van Duyne

ACS Award in Analytical Chemistry, Northwestern University; 1970 RCSA grant: Excimer formation mechanisms in electron transfer chemiluminescence

Donald J. Darensbourg

ACS Award in Inorganic Chemistry, Tulane University; 1971 RCSA grant: Nature of the metal-hydrogen bond in heterogeneous and homogeneous catalysts

Timothy P. Lodge

ACS Award in Polymer Chemistry, University of Minnesota; 1982 RCSA grant: Diffusion of star-branched polymers in concentrated solutions of linear polymers by quasi elastic light scattering

Patricia A. Thiel

Arthur W. Adamson Award for Distinguished Service in the Advancement of Surface Chemistry, Iowa State University; 1984 RCSA grant: The interaction of water with cyclic hydrocarbons on a ruthenium surface

Joan Selverstone Valentine

Alfred Bader Award in Bioinorganic or Bioorganic Chemistry, Rutgers; 1973 RCSA grant: Transition metal complexes of small molecules: SO and S

Larry E. Overman

Herbert C. Brown Award for Creative Research in Synthetic Methods, University of California, Irvine; 1971 RCSA grant: Catalytic importance of aspartic acid-histidine interactions

Helen E. Blackwell

Arthur C. Cope Scholar Awards, sponsored by the Arthur C. Cope Fund, University of Wisconsin, Madison; 2005 RCSA grant: Regulation of bacterial communication pathways with synthetic ligands

Jeffrey Johnson

Arthur C. Cope Scholar Awards, sponsored by the Arthur C. Cope Fund, University of North Carolina at Chapel Hill; 2006 RCSA grant: Tandem dynamic kinetic resolution

Matthew Sigman

Arthur C. Cope Scholar Awards, sponsored by the Arthur C. Cope Fund, University of Utah; 2000 RCSA grant: Oxidative kinetic resolution of secondary alcohols with chiral palladium complexes

Lawrence Dahl

F. Albert Cotton Award in Synthetic Inorganic Chemistry, sponsored by the F. Albert Cotton Endowment Fund, University of Wisconsin; 1959 RCSA grant: Structural studies of unusual organometallic compounds

Martin Zanni

Nobel Laureate Signature Award for Graduate Education in Chemistry, sponsored by Mallinckrodt Baker, University of Wisconsin, Madison; 2002 RCSA grant: Protein solvation structures and dynamics studied with two-color 2D infrared spectroscopy

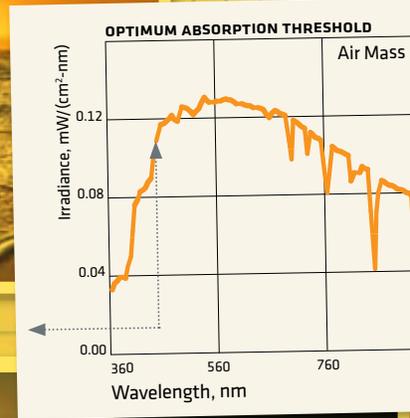
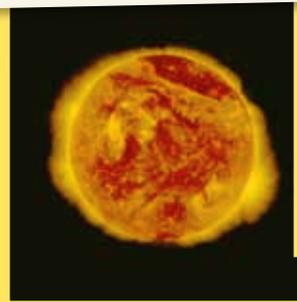
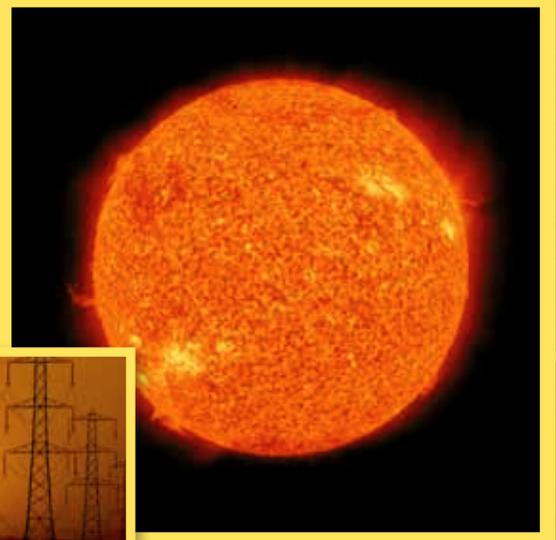
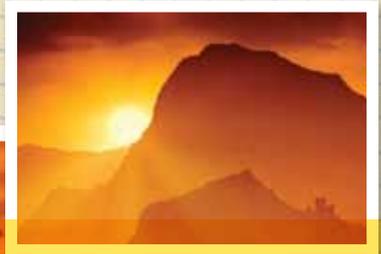
Robert J. Madix

Gabor A. Somorjai Award for Creative Research in Catalysis, sponsored by the Gabor A. & Judith K. Somorjai Endowment Fund, Stanford University; 1966 RCSA grant: Trapping sites in gas-solid collisions

Mark Barteau

Catalysis Award, Michigan Catalysis Society, Giuseppe Parravano Memorial Award for Excellence in Catalysis Research, University of Delaware; 1983 RCSA grant: A surface science investigation of metal oxide catalysts: acid-base reactions of alkynes on ordered oxide surfaces

2010 Sciablog



Scialog 2010: Accelerating Solar Energy Conversion Science

Scialog—shorthand for science dialog—is crucial to U.S. global leadership in the sciences and technology in the 21st century. It refers at once to dialog across fields of science, dialog among scientific researchers, dialog with science students and dialog with the general public.

Making those various forms of interactions commonplace is essential: only with such far-reaching engagement will U.S. leadership in the sciences and technology—and, therefore, innovation and jobs—be maintained.

Scialog is a new program from Research Corporation for Science Advancement (RCSA), the nation's first foundation devoted wholly to science.

The topic for the first-ever three-year Scialog round of grants and convenings was suggested by RCSA's Presidential Advisory Committee, (page 28) and is focused on overcoming bottlenecks to improving efficiencies in solar energy conversion. Initial grant proposals were vetted by a panel of top scientists in that area of study. This peer-review panel (page 16) was chaired by Nathan Lewis, Caltech's George L. Argyros Professor of Chemistry and director of the U.S. Department of Energy's \$122-million research hub focusing on development of solar fuels.

The October, 2010, Scialog convening at Biosphere 2 was co-sponsored by the National Science Foundation, Division of Materials Research, with in-kind contributions from the University of Arizona. Fifty participants came together for more than two days. Attending were Scialog Fellows engaged in high-risk/high-reward solar-energy research, a number of NSF grantees in the solar area, as well as top national authorities in photovoltaics and solar fuels. They gave presentations on their research projects and engaged in sessions of structured dialog.

The conference was facilitated by Elizabeth McCormack, Dean of Graduate Studies and Professor of Physics at Bryn Mawr College. The Scialog process culminated in the formation of new research teams, comprised of conference participants, who had the opportunity to submit proposals for additional RCSA funding above the \$1.35 million already awarded to 13 grantees.

RCSA President and CEO James Gentile opened the conference by highlighting Scialog's goals of building a network among researchers, creating a community to approach difficult problems in new and innovative ways, and producing "transformative" discoveries—breakthroughs that change the way scientists see the world and consequently change the world itself.

Early career scientists whose proposals were funded in the first round include:

John M. Lupton & Eugene Mischenko
Physics, University of Utah \$250,000

Nanoplasmonic focusing of light fields to amplify non-linear optical effects in composite photovoltaics

This application brings together a condensed matter theorist and a polymer material scientist to address the low solar conversion efficiencies of polymer solar devices. They propose to take advantage of non-linear optical effects not generally considered in solar devices to up-convert two red photons (not absorbed by organic polymers) to a blue photon, which is absorbed. They propose to do this by tuning materials to favor radiative triplet annihilation of long-lived triplet states at donor acceptor interfaces produced by red photon absorption. They also believe their approach can be used to improve charge separation in organic materials, another known problem of this type of solar device. The work is risky because up-conversion has been difficult to accomplish with reasonable efficiency, but the combined theoretical and new materials approach was seen as promising.

Alan Heyduk
Chemistry, University of California, Irvine \$100,000

Molecular approach to converting solar energy into chemical fuel

Heyduk proposes to build inorganic systems based on metal-ligand coordination compounds of common metals capable of accepting two electrons—one electron to the metal center and one to the ligand. He would then couple the electron transfer to photo-excitation and ultimately the transfer of the two electrons in a concerted fashion to produce hydrogen. While the overall process he proposed was viewed as impractical for a complete solar cell, his contribution to figuring out a way to get two electrons stored was seen as highly innovative and based on his expertise and creativity in fundamental coordination chemistry.



Alan Heyduk



Sean J. Elliott
Chemistry, Boston University
\$100,000

Transforming heme proteins into solar driven redox catalysts by site-directed zinc porphyrin mutation

Elliott proposes to genetically modify a non-photosynthetic bacterium (*Shewanella oneidensis*, "So") that contains a robust hydrogenase system into one that captures and uses light to drive its metabolism and, most importantly, hydrogen generation. So possesses multi-heme cytochromes capable of shuttling electrons to electrodes and grows well as a film on solid supports such as graphite and metal oxides used in electrodes. Consequently, it could readily be grown on the surface of an electrode and suitably modified to convert photonic energy to chemical fuels, i.e., hydrogen. Elliott has some encouraging early results and the idea of coupling a robust, genetically modified biological system to a chemical one was seen as highly innovative—an early step towards "synthetic biology" in the solar energy field.



Sean Elliott

Stefan Lutz
Chemistry, Emory University
\$100,000

Directed evolution of hydrogenase for efficient light-driven hydrogen production via quantum dot-enzyme hybrid systems

In biological systems iron-sulfur containing proteins called ferredoxins transfer electrons to a protein assembly of enzymes known as "hydrogenases" to produce hydrogen. Lutz proposes to couple a hydrogenase to CdSe quantum dots (QDs) to produce hydrogen directly from sunlight. CdSe QDs are known to readily absorb light to promote electrons to excited states (excitons) with sufficient energy to drive hydrogen production by hydrogenase. However, the transfer of electrons from the QDs to the hydrogenase is inefficient resulting in low efficiency conversion of photons to hydrogen. The fundamental problem is that the association and orientation of the hydrogenase to the QD is such that the excitons annihilate before the excited electron can be transferred to the hydrogenase. Lutz proposes to use directed evolution of the hydrogenase to optimize its association with the QD resulting in electron transfer at a faster rate than exciton annihilation.

Wide-ranging discussions

Conference talks and discussions ranged from precise technical details on how to squeeze more useable power from the humble photon, the basic constituent of light, to the tremendous need for a new global industrial revolution centered on clean, renewable energy. It's a revolution that must occur within the next two decades if 2050's 10 billion people are to live comfortably on planet earth, according to Scialog keynote speaker Arun Majumdar, Director of the U.S. Department of Energy's (DOE) Advanced Research Projects Agency-Energy (ARPA-E).

Also delivering keynote addresses were Nathan Lewis, Caltech, head of the DOE's new, \$122-million solar fuels hub; Eric Mazur, noted Harvard expert on science education and a pioneer of "black silicon," a potential breakthrough material in solar power; Roger Angel, the University of Arizona Kavli Prize winner and MacArthur Foundation "genius grant" awardee; and Arizona State University Professor Thomas Moore, a major national expert in photosynthesis and solar energy.

Majumdar warned that the world's need for renewable energy is fast becoming "the mother of all necessity," especially in the fastest growing, least developed regions of the globe. He pointed out that the opportunities for business and industry in filling the needs for solar and other forms of renewable energy, both abroad and domestically, are likely to be enormous in the coming decades. He also noted that America will have to become more efficient in the way it uses energy—through smart electrical grids, energy efficient buildings, and new modes of fueling transportation.

Majumdar said it is time for the U.S. to work toward the 21st-century equivalent of the 1969 moon shot, this time for energy independence, which he called a "sun shot."

"So here is one aspect of that sun shot," he said. "Photovoltaics at \$1 per watt fully installed; by 2017 demonstration of all key components and installation methods and systems at least five megawatts in size and initial production orders made. This target could be met with systems installed in the ground and/or in buildings, and with earth-abundant materials and recyclable components that meet all the applicable safety and environmental standards."

Catalyzing the 'sun shot'

Majumdar said the DOE is planning to target funds to catalyze the sun shot and make America energy independent. He praised RCSA's efforts to help accelerate the pace of innovation in solar energy conversion, observing:

"It was a pleasure to participate in the vibrant technical discussions at Scialog. Given the talent and enthusiasm of the participants, I would not be surprised in the least if the collaborations formed at the event led to major new scientific thrusts."

One aspect of the DOE sun-shot funding initiative is headed by another Scialog keynote speaker, Caltech's Nate Lewis. He is in charge of the Energy Department's Joint Center for Artificial Photosynthesis (JCAP), a new "Energy Innovation Hub" recently funded at \$122 million to develop solar fuels.

Lewis said scientists can best contribute to the demand for renewable energy by coming up with "disruptive" discoveries—those that allow technology to "do new things in entirely new ways." He quoted DOE Secretary Steve Chu as saying, "Science and technology can give us better choices than we have now," and, as an example, Lewis challenged Scialog attendees to come up with a working model of artificial photosynthesis—something that has yet to be achieved, despite scientists' growing understanding of how plants convert sunlight into energy.

Lewis outlined the major bottlenecks—at least those currently apparent—to breakthrough discoveries in three main areas of solar energy conversion: photovoltaics, solar fuels and solar thermal power generation.

Mazur's 'black silicon'

Eric Mazur has overcome a bottleneck when it comes to making silicon into an efficient solar conversion material. He and his colleagues discovered—somewhat serendipitously, Mazur is quick to admit—"black silicon," a high-efficiency solar conversion material.

Mazur discussed the technical aspects of black silicon in his keynote speech at Scialog, saying that in 1990 his research team, led by associate James Carey, first produced the curious material by hitting a standard silicon wafer with a series of 100-femtosecond laser pulses (a femtosecond is one quadrillionth of a second) in a chamber with sulfur hexafluoride gas.

"The region of the silicon that had been hit by the femtosecond laser pulses turned completely black," Mazur said. More interestingly, the process greatly increased the material's ability to absorb sunlight, including wavelengths from near UV to near infrared. (Most solar cells work only in a limited portion of the visible light spectrum.) The laser pulses etch a rough surface



Mu-Hyun Baik

Mu-Hyun Baik
Chemistry, Indiana University,
Bloomington \$100,000

Toward converting CO₂ to fuel: A computer-aided experimental discovery of novel CO₂ reduction catalysts

While Baik is a theorist, he proposes to combine experiment and theory to develop more efficient metal-ligand systems to photochemically reduce CO₂ to formic acid. His hypothesis, gleaned from a theoretical analysis of known catalysts and their presumed catalytic cycles, is that the current view of the role of the ligand in these ruthenium terpyridine and bipyridine systems is wrong. His calculations suggest that the active species cannot be the ones proposed and that consequently efforts to improve these systems has failed to make progress because it is based on false assumptions about the ligand structure of the active species. If he is right, he might open an entirely new approach to designing ligand-metal systems for photo-catalysis of solar fuel production.

Raymond E. Schaak
Chemistry, Pennsylvania State
University \$100,000

New chemical routes for discovering and improving visible-light photocatalysts

Schaak is an expert at low temperature solution routes to complex bulk solids and nanocrystals with targeted properties. He proposes to use his synthetic expertise to build a library of new oxynitride photo catalysts from inexpensive and non-toxic materials. He proposes to control the shape and size of these new materials so that the role of composition, size and shape of the nanocrystals in efficient photo catalysis can be determined; thereby charting a rational route to better materials. While "discovery" driven, Schaak's approach to these new materials was seen as highly creative and of significant potential to lead to improved photo catalyst materials.

Hugh Williams Hillhouse
Chemistry, Purdue University
\$100,000

Photoconversion physics in quantum-wire arrays with double-gyroid topology

Hillhouse proposes to study multiple exciton generation (MEG) from a single photon in double-gyroid (DG) arrays. These arrays consist of thin films of highly ordered, interconnected arrays of nanowire segments. There is evidence that MEG occurs in one-dimensional quantum dots, but exciton lifetimes are too short to be efficiently harvested before recombination. The symmetry and topology of the DG structure generates an extra degeneracy that enhances the density of states compared to a straight one-dimensional quantum wire. Consequently, Hillhouse hypothesizes that the DG films may possess the MEG properties close to the one-dimensional wires, but retain the more favorable charge transport properties typically found in 3D materials. If they do they would represent very promising new materials for solar energy conversion to electricity or fuels. The DG arrays represent an intriguing new nano-material structure that can be produced in an easily controlled replicative process from a wide range of materials, opening the possibility of tuning their quantum properties.

Joan M. Redwing
Chemistry, Pennsylvania State
University \$100,000

Synthesis and characterization of core-shell wire heterostructures

A limiting factor in In-Ga-N photovoltaic devices is getting thick enough films to absorb light efficiently while maintaining crystal quality of the film. Redwing proposes to solve this problem by building nanowires by growing thin layers of GaN/AlN on a high aspect ratio Si wire and thereby producing an optically thick nanorod with a highly textured surface. She hypothesizes that this will be a way of getting higher total optical absorption out of an optically thin layer by having lots of internal light trapping in the core shell structure. If this approach works, it could lead to the design of a new class of promising materials for photovoltaics.



Joan Redwing

and carve deep valleys into the silicon wafer. (“Deep” is a relative term, of course. The “valleys” are actually only several hundred microns deep.) This treatment enhances the silicon’s ability to absorb visible light. Subsequent studies revealed that a great deal of sulfur is attached, through melting, to the surface of the silicon that is missed by the laser strikes.

Mazur has formed a company to take advantage of black silicon’s sensitivity—in optical detectors it is roughly 100 to 500 times more sensitive to light than untreated silicon. The material is being studied for use in generating electricity from sunlight.

Concentrating sunlight

Another keynote speaker, world-renowned telescope designer Roger Angel, of the University of Arizona, also has a promising solar-energy technology he would like to see commercialized. Angel told Scialog attendees how he has taken his expertise in constructing giant mirrored telescopes and applied that knowledge to engineering a concentrating photovoltaic system that focuses sunlight on a highly efficient triple-junction solar cell. This type of solar cell was originally designed for use in orbiting satellites and is too expensive for use in ordinary solar panels that use unfocused sunlight. Angel described the time and effort he spent engineering a relatively inexpensive solar collector system to focus sunlight at 1,000 times its normal intensity onto the triple-junction cell so that the use of the expensive cell here on earth is now approaching economic viability.

Angel believes his solar-concentrator device, if replicated tens of thousands of times and spread over roughly 120-square miles of sun-drenched land in the Southwest, could provide enough electricity to power most of the United States.

Tom Moore, Arizona State University chemistry professor and a world expert on the cutting-edge move to meld photosynthesis with artificial systems, joked that there is nothing wrong with our planet’s changing climate that could not be fixed by simply moving the earth’s orbit a mere 350,000 kilometers farther from the sun.

“That’s a proposal that’s in the literature, and we take full credit for it,” Moore said, triggering laughter in his audience.

He went on to discuss ideas concerning goals for artificial photosynthesis inspired by Oliver Morton’s recent book, *Eating the Sun*. Moore quoted Morton, chief news and features editor at *Nature* magazine, as saying, “When our knowledge of life’s most fundamental processes allows us to begin redesigning and embellishing them rather than just studying them, a whole range of new chemical technologies will become possible.”

Moore outlined ways that chemistry and physics are being used to redesign photosynthesis and discussed how Scialog attendees

would be contributing to a future in which synthetic biology will help power the planet.

The solar funding landscape

The Scialog conference also featured a lively panel discussion about the funding landscape for solar energy researchers, with Linda Sapochak, a chemist and head of the Division of Materials Research for the National Science Foundation, and Elaine Ulrich, an optical scientist and senior legislative aide to U.S. Representative Gabrielle Giffords.

Sapochak, whose office oversaw more than a billion dollars in awards in 2009, explained key NSF programs and provided advice to grant seekers. She also reviewed the NSF's Solar Energy Initiative, which encourages interdisciplinary research and includes math as a core discipline.

"I believe the Scialog Conference proved to be an excellent mechanism to leverage RCSA and NSF's investment in solar energy research and initiate new collaborations between research communities," Sapochak said.

Ulrich provided information about congressional funding and support for research. She advises Giffords, a member of the House Committee on Science and Technology and a national leader in advocacy for solar energy. Ulrich urged researchers to establish relationships with their own congressional representatives and outlined ways to build these connections. She emphasized that this both helps researchers receive visibility and funding for their projects, and she added that it educates our leaders and fellow citizens about the importance of scientific discovery in creating national prosperity and security.

Supplemental funding

Following the meeting, the Scialog process continued to move forward in 2010. By November, the five members of the Scialog review panel who attended the conference (Nate Lewis, Tom Moore, Krishnan Rajeshwar, Mats Selen and Richard Powell) had reviewed the supplemental proposals developed at the conference and made recommendations for funding three proposals, each at \$100,000: These proposals involve six Scialog Fellows and three new faculty:

Bio-Inspired Electro-Optic Structure for Silicon Photovoltaics

Rene Lopez (University of North Carolina, Chapel Hill), Joan Redwing (Pennsylvania State University and Scialog Fellow) and Kathleen Melde (University of Arizona)

Sample review comment: "I really liked this proposal. It was clear, innovative, and the stated objectives were very relevant to the solar PV mission...I was impressed by how cohesive and cogent the arguments were for support."

Paul A. Maggard, Jr. Chemistry, North Carolina State University \$100,000

Molecular-level design of metal-oxyfluoride/organic solids for Visible-Light Photocatalysis

The discovery of an efficient and stable photocatalyst that absorbs in the visible region of the spectrum is an important target of solar conversion research aimed at producing fuels such as hydrogen. Maggard hypothesizes that he can solve this problem with clever solution-based hydrothermal synthetic techniques aimed at heterometallic oxides/organics with a combination of d^0/d^{10} (e.g. Nb^{5+}/Cu^+) or d^0/d^6 (e.g. Nb^{5+}/Co^{3+} (low spin)) electron configurations. Similar complexes have been shown to have metal-to-metal charge transfer transitions in the visible spectrum. Consequently, investigation of metal-organic catalysts with this electronic structure offers the potential of leading to new materials with the desired visible light band gaps and photocatalytic activity.



Paul Maggard

David E. Cliffel Chemistry, Vanderbilt University \$100,000

Biologically optimized protein films for solar energy conversion

Cliffel proposes to develop methods for applying thin films of Photosystem I (PSI) and Photosystem II (PSII) from thermophilic cyanobacterium to electrode surfaces and optimizing the electron transfer between the electrode surface and metalloproteins in the photosystems. Thermophilic bacteria are known for their especially heat-stable enzymes, which would be an important property in a photocell. Cliffel has significant preliminary work in getting functioning electrodes with PSI adsorbed and is working to optimize it and develop similar electrodes for PSII. The combination of one electrode of each type in a functioning cell would split water into hydrogen (fuel) and oxygen. While this is high risk and a long shot for a functioning electrochemical cell at this stage, it represents the very early stages of synthetic biology needed to take advantage of the huge potential of nature's catalysts.

Jie Shan
Physics, Case Western Reserve
University \$100,000

Overcoming Shockley-Queisser Limit on PV solar-energy conversion efficiency: Multiple exciton generation in one-dimensional nanostructures

The efficiency of photovoltaic conversion of solar radiation into electrical power is limited by the dissipation of part of an absorbed photon's energy into heat. In order to significantly increase solar cell efficiency by reduction of this energy loss, fundamentally new physical processes must be found. Multiple exciton generation (MEG), in which a single absorbed photon creates two or more electron-hole pairs (excitons), is one such possibility, although the very existence of MEG is controversial. Shan proposes to examine one-dimensional semiconductor nanowires (Si, Ge, InAs), semiconducting single-walled carbon nanotubes and graphene nanoribbons using optical pump/terahertz (THz) spectroscopy and other methods to observe MEG and quantify the phenomenon. She is an expert in the above technique and offers a convincing experiment to answer fundamental questions about the existence (and extent) of MEG in nanowires. If this approach is successful it could open a new mechanism for more fully exploiting sunlight for energy conversion.



Jie Shan

High Spatial Resolution Electrochemistry of Biological Inspired Systems

Stefan Lutz (Emory University and Scialog Fellow), Sean Elliott (Boston University and Scialog Fellow) and David Cliffler (Vanderbilt University and Scialog Fellow)

Sample review comment: "It is a unique approach that combines expertise in nanomaterials and surface chemistry with molecular catalyst design and synthesis with catalyst testing. The collaboration among the three participants is essential for the project to work and successful results will have a major impact on CO₂ reduction."

Artificial Nanoscale Enzymes for CO₂ Reduction Catalysis

Raymond Schaak (Pennsylvania State University and Scialog Fellow), Alan Heyduk (University of California, Irvine and Scialog Fellow) and John Gilbertson (Western Washington University)

Sample review comment: "A brilliant idea to make use of the intersection of two surfaces to make a three-dimensional site for catalysis. Must fund."

Assessment and follow-up

Rigorous scientific assessment has been an integral component of the Scialog initiative from its inception. RCSA views the initiative as an experiment to test whether this approach to identifying and funding highly innovative ideas coupled with intensive dialog and network building can accelerate the pace of transformative science. In 2010 RCSA hired Datascope Analytics, a data-centric consulting firm, to collaborate with the RCSA scientific staff on the design and analysis of a Scialog social network survey. The managing partners of Datascope Analytics are Dean Malmgren, Ph.D. in chemical and biological engineering, and Mike Stringer, Ph.D. in physics and a fellow at the Kellogg School of Management, Northwestern University. Both are superb data analysts with significant expertise in network analysis. They have been asked to construct assessment surveys to determine the evolving network connectivity of participants as they go through the Scialog process.

At the 1st Annual Scialog Conference participants were asked to categorize their relationships into Unfamiliar, Aware, Discussion, or Collaboration to reflect a simple model of the steps required to actually reach a point where two participants can collaborate. Already, these initial surveys have yielded intriguing results that suggest the Scialog methodology is effective in accelerating the formation of cross-disciplinary collaborative teams. In addition, RCSA will be carefully analyzing the tangible scientific output of Scialog Fellows as the initiative unfolds and objectively determining if Scialog is an effective approach for creating more rapid scientific breakthroughs.

As the initiative unfolds, the long-term effectiveness of the Scialog process, such as lasting collaborations, increased research productivity, and breakthrough scientific discoveries, will also be

measured. For this analysis, we plan to use publicly accessible databases, such as Thomson Reuters Web of Science citation database, coupled with participant surveys. Pursuing this program of rigorous scientific evaluation of the Scialog process itself will be useful practically as well as scientifically important.

Key insights from the 2010 Annual Scialog Conference

- Out of 36 active solar energy researchers, the Scialog conference resulted in an average of 12.7 new awareness connections, 9.0 new discussion connections, and 1.2 new collaboration connections to other researchers.
- Over 60% of new collaboration connections were made between individuals who were unfamiliar with each other prior to the conference.
- Whereas traditional conference activities (formal presentations, poster sessions, and undirected dialog) tend to lead to awareness and discussion among participants, writing joint proposals is a strong incentive for Scialog participants to collaborate.
- Awareness and discussion connections made during the Scialog conference are significantly more interdisciplinary than the pre-conference awareness and discussion connections, whereas new collaboration connections are not significantly more interdisciplinary than the pre-conference collaborations.
- About 75% of the most innovative ideas tend to be shared during formal presentations (52%) and undirected dialogs (23%).
- Over 45% of new collaboration connections were made between individuals that thought each other's ideas were very innovative.

Undirected dialog fosters the most referrals.

Also in 2010, it was determined that a total of \$1.55 million of remaining funds designated for the first Scialog initiative on solar energy conversion would be withheld and used for a second round of awards and supplemental funding at the 2nd Annual Scialog Conference. The call for a second round of proposals was made immediately following the November 2010 RCSA Board of Directors meeting, with a proposal submission deadline of January 15, 2011. The second call for proposals was to emphasize the need for highly innovative ideas. Those not chosen in the first round were deemed incremental—not high-risk—not innovative. Awards for the second call are to be announced following the May 2011 Board meeting.

A second round of funding gives RCSA an opportunity to expand the Scialog network of recently tenured solar energy scientists working in collaborative, cross-disciplinary teams. Our challenge will be integrating this new cohort into the existing network. In late 2010 Foundation personnel were already at work planning the 2011 Scialog conference on solar energy conversion. Their goal is to make this transition smoothly and to leverage the effectiveness of the coalescing network.



Frank Osterloh

Frank E. Osterloh
Chemistry, University of California,
Davis \$100,000

Bottom-up assembly of nanoscale heterojunctions for photochemical energy conversion

A limiting factor for many nanomaterial-based solar devices is that electron hole pairs are not separated efficiently, causing recombination and energy loss. This occurs because in nanomaterials space charge layers are too weak to enable efficient charge separation. Osterloh proposes to assemble nanoparticles into bulk heterojunctions, where charges are separated at the interfaces due to the offset band edges of the adjacent nanoparticles. He will create these "offsets" by associating the nanoparticles with either negative ions (anions) or positive ions (cations). These ions adsorb to the surface of the nanoparticles, creating an electric field that shifts the band edge up (for anions) and down (for cations). He hypothesizes that this will lead to better charge separation and consequently more efficient solar energy conversion. This approach has been used in other semiconductors to shift band gap potentials. He believes the effect will be much larger because of the emergence of the nanoparticles in the electric field of the ions. An important advantage is that he is using inexpensive and common oxides such as VO_2 , Cu_2O , and Fe_2O_3 in his studies, so if this works it could make the related solar devices much less expensive.

Scialog 2010 Peer Review Panel



Nate Lewis

Nathan Lewis, Chair The George L. Argyros Professor of Chemistry, California Institute of Technology. Dr. Lewis has also served as the Principal Investigator of the Beckman Institute Molecular Materials Resource Center at Caltech since 1992. He is currently director of the Joint Center for Artificial Photosynthesis Innovation Hub, a \$122-million project to develop clean, renewable fuels using solar energy.

Carol A. Bessel Program Director, Fuels from Sunlight Innovation Hub, Office of Basic Energy Sciences, U.S. Department of Energy. Dr. Bessel's research interests are varied, ranging from the synthesis and characterization of inorganic coordination complexes to the use of graphite nanofibers as supports for methanol fuel cells and the application of supercritical carbon dioxide as a solvent in chemical mechanical planarization processes. Prior to coming to BES, she shared responsibilities for the Chemical Catalysis and Chemical Structure, Dynamics and Mechanisms Programs within the Chemistry Division of the National Science Foundation (NSF).

Nancy Haegel Distinguished Professor, Department of Physics, Naval Postgraduate School. Professor Haegel joined the faculty of NPS in 2003. She previously served on the faculties of the Materials Science and Engineering Department at UCLA and the Physics Department at Fairfield University. She conducts research in the areas of transport imaging in solid state devices, modeling of low temperature and far infrared detectors, solar cell characterization and development of polymer emitters for military applications.

Prashant V. Kamat Professor of Chemistry & Biochemistry and Senior Scientist at Radiation Laboratory (a DOE funded laboratory on the campus of Notre Dame) and Concurrent Professor in the Department of Chemical and Biomolecular Engineering, University of Notre Dame. Dr. Kamat has written more than 350 peer-reviewed journal papers, review articles and book chapters. He has edited two books in the area of nanoscale materials.

Tom Moore Professor of Chemistry & Biochemistry, Arizona State University. Dr. Moore's research focuses on the design and assembly of bio-inspired constructs for solar energy conversion, catalysis and signal transduction. The incorporation of artificial antennas and reaction centers into model biological membranes to make solar energized membranes is one of the first steps towards assembling nanoscale devices capable of carrying out human-directed work.

Teri Odom Associate Professor and Dow Chemical Company Research Professor in the Department of Chemistry and Materials Science and Engineering at Northwestern University. Dr. Odom's

research focuses on controlling materials at the 100-nanometer scale and investigating their size and shape-dependent properties. She has developed multi-scale nanopatterning tools that can generate noble metal (plasmonic) structures with exceptional optical properties.

Richard C. Powell Professor Emeritus of Optical Sciences and Professor Emeritus of Materials Science, University of Arizona. Dr. Powell is a fellow of the American Physical Society as well as the Optical Society of America. His research centered on doped crystals and glasses: energy transfer, charge transport, vibronic spectra and radiationless processes. He was also instrumental in development of four-wave mixing and multiphoton pico-second spectroscopy techniques.

Krishnan Rajeshwar Distinguished University Professor in Chemistry & Biochemistry, and Associate Dean of the College of Science, University of Texas at Arlington. Editor, *The Electrochemical Society Interface* magazine, and a Fellow of the Electrochemical Society. Dr. Rajeshwar's research group is studying novel *in situ* diagnostic tools for semiconductor film formation, and spectroscopic probes of charge and mass transport at semiconductor/electrolyte interfaces. He is also investigating the mechanisms of heterogeneous photocatalysis for toxic waste treatment and disinfection.

Linda Sapochak Program Director, Division of Materials Research (DMR), National Science Foundation (NSF). Dr. Sapochak's research management portfolio includes the Solid State and Materials Chemistry (SSMC) Program, the CHE-DMR-DMS Solar Program and the Emerging Frontiers in Engineering Research (EFRI)-Science in Energy and Environmental Design (SEED): Engineering Sustainable Buildings Program. She currently chairs the Energy Working Group in the Mathematical & Physical Sciences (MPS) Directorate.

Mats A. Selen Professor, Department of Physics, University of Illinois, Urbana-Champaign. Dr. Selen's expertise is in data acquisition and Charm Physics; his work in charm hadronic decays and excited states was recognized by the American Physical Society when he became a Fellow in 2006. He is passionate about improving the quality of science education in the U.S.

Luping Yu Professor of Chemistry, University of Chicago. Dr. Yu's research is focused on the interfacial area between organic chemistry and materials science. This area has rich opportunities for organic chemists both in fundamental science and practical technologies. He is also interested in development of new polymerization approaches for the synthesis of electro-optical polymers and biocompatible polymers, synthesis and characterizations of molecular electronic components, new surface reactivity and supramolecular assembly approaches for self-assembly of nanostructured materials.



2010 Awards



Building Communities in Science Teaching: Cottrell College Science Awards



The Cottrell College Science Awards program provides the first proposal funding for early career faculty in public and private primarily undergraduate institutions (PUIs) in the United States. The program also offers participants expertise and advice in developing their first requests for research funding.

The Single-Investigator Cottrell College Science Awards support research in astronomy, chemistry, physics and closely related fields that significantly overlap with research in these three disciplines. The projects proposed are judged on the basis of scientific originality, significance, feasibility, overlap with the three core disciplines and the ability of the institutional environment to sustain the activity. The involvement of undergraduate students in meaningful ways in the research is expected, and is an important factor in most awards. Eligible faculty must be within the first three years of a first tenure-track appointment and within 12 years of receiving a doctoral degree.

After review by the Foundation staff and outside referees, the composite proposal material is evaluated by an advisory committee of scientists drawn from the academic community. Awards are made to the institution on behalf of the individual investigator following approval by the Foundation's Board of Directors.

The Multi-Investigator Cottrell College Science Awards proposals were received in 2010, and will be announced in 2011. The 2010 Single-Investigator Cottrell College Science Awards totaled \$2 million in grants to support 57 early-career scientists.

The Cottrell Scholar Awards

In the fall of 2010, RCSA named 11 honorees as Cottrell Scholars.

The Cottrell Scholar Awards recognize leaders in integrating science teaching and research at America's leading U.S. research universities. They also represent admission to an exclusive group of scholars—now about 250 in total—who have been singled out for leadership in combining teaching and research: a pressing priority for a nation that seeks to perpetuate its extraordinary history of scientific preeminence in the face of ever-increasing global competition.

Cottrell Scholars each receive \$75,000 and admission to an exclusive community of scholars.

The 11 Award-winners are all early career scientists—assistant professors in chemistry, physics or astronomy. They are from

2010 SINGLE-INVESTIGATOR CCSA RECIPIENTS

Edith M. Osborne, Chemistry

Angelo State University, San Angelo, TX
Novel Selenocysteine Insertion System for Protein Labeling and Human Selenoprotein Expression

Tamara D. Hamilton, Chemistry

Barry University, Miami Shores, FL
Solid-State Synthesis of Porphyrins and Construction of Porphyrin-Walled Metal-Organic Polyhedra

Jennifer R. Kowalski, Biology

Butler University, Indianapolis, IN
Identification and Characterization of Anaphase Promoting Complex Substrates that Regulate Synaptic Transmission in C. Elegans

Erik C. Wasinger, Chemistry

California State University, Chico
Electronic and Geometric Characterization of Metal-Free and Metal-Bound Sulfur Radicals

Hope A. Johnson, Biology

California State University, Fullerton
Bacterial Mn(II) Oxidation and its Role in Oxidative Protection

Joshua R. Smith, Physics

California State University, Fullerton
Extending the Astronomical Reach of Gravitational-Wave Detectors with All-Reflective Interferometry

Shahab Derakhshan, Jr., Chemistry

California State University, Long Beach
Design, Synthesis and Physical Properties of Some Novel Brownmillerite Compounds

Yohannes Abate, Physics

California State University, Long Beach
Nanoscale Surface Plasmon Polariton Local Excitation and Focusing by Near-field Microscopy for High Efficiency Organic Photovoltaics

Michael J. Burin, Physics

California State University, San Marcos
Characterizing the Subcritical Transition to Turbulence in Taylor-Couette Flow

Philip J. Costanzo, Jr., Chemistry

California Polytechnic State University, San Luis Obispo
Incorporation of Latent Cysteine-Like Residues for the Development Novel Coupling Chemistry

Lori Robins, Chemistry

California Polytechnic State University, San Luis Obispo
Discovery of Helicobacter Pylori Aldo-Keto Reductase Inhibitors

Dwight R. Luhman, Physics

Carleton College, Northfield, MN
The Effect of Disorder on the Superfluid Transition in Two-Dimensional Liquid Helium Films

Todd T. Kroll, Chemistry

Central Washington University, Ellensburg, WA
Systematic Identification of Protein-Protein Interactions Mediating Induction of Functional Areas in Mammalian Neocortex

2010 SINGLE-INVESTIGATOR CCSA RECIPIENTS, CONTINUED

Nathan B. Magee, Physics

College of New Jersey, Ewing, NJ
Experimental Investigation of Depositional Mechanisms in Ice Crystals under Cirrus-Like Conditions

Jonathan R. Scheerer, Chemistry

College of William and Mary, Williamsburg, VA
Chiral Non-racemic Bicyclic Diketopiperazines: A Common Precursor to Explore Diverse Asymmetric Reactions

Annabel Muenter Edwards, Chemistry

Denison University, Granville, OH
Water Transport in a Hydrophobic Layer: ATR-IR Spectroscopy Studies of Water Movement in Films of Plant Cuticular Wax Components

Albert Korir, Chemistry

Drury University, Springfield, MO
Separation and Characterization of Heparan Sulfate- and Heparin-Derived Oligosaccharides Important for Protein Binding

Amitabh Joshi, Physics

Eastern Illinois University, Charleston, IL
Quantum Memory and Information Processing Using Multi-level Electromagnetically Induced Transparency System

Jeffrey A. Rood, Chemistry

Elizabethtown College, Elizabethtown, PA
Solvent and Temperature Effects on the Structure and Luminescent Properties of Metal Phosphinates

Eduard Bitto, Chemistry

Georgian Court University, Lakewood, NJ
Origins of the Substrate Specificity of Erythrocyte Pyrimidine 5'-Nucleotidase Type 1

Timothy W. Funk, Chemistry

Gettysburg College, Gettysburg, PA
Transition Metal-Catalyzed Oxidations of Organic Molecules without Traditional Oxidants

Richard S. Vallery, Physics

Grand Valley State University, Allendale, MI
Investigating Polymer Confinement Effects in Model Polymer Nanocomposite Systems Using Positron Annihilation Lifetime Spectroscopy

Nicole L. Snyder-Lee, Chemistry

Hamilton College, Clinton, NY
The Synthesis and Evaluation of Carbohydrate-Porphyrin Conjugates as Asymmetric Catalysts

Adam W. Van Wynsberghe, Chemistry

Hamilton College, Clinton, NY
Accurate Evaluation of Association Rate Constants of Influenza Neuraminidase Inhibitors

Rachel Levy, Mathematics

Harvey Mudd College, Claremont, CA
A Mathematical and Experimental Study of Surfactant Spreading on Thin Liquid Films

10 universities—with two from the University of Virginia—and seven states—with three from New York and two each from California and Virginia.

Originality, feasibility, and the prospect for significant fundamental advances to science are the main criteria for judging the candidates' research, while contributions to education, especially at the undergraduate level, aspirations for teaching, and the candidates' proposed strategies to achieve educational objectives, are factors in assessing their teaching plans.

The 2010 Cottrell Scholar honorees are:

Sarbajit Banerjee Assistant Professor of Chemistry, SUNY at Buffalo. Banerjee's research focuses on understanding the influence of finite size on phase transitions and intercalation processes in vanadium oxides.

Alberto Daniel Bolatto Assistant Professor of Astronomy, University of Maryland, College Park. Bolatto is studying the drivers of galaxy evolution: gas reservoirs, molecular fractions, and star formation.

Duncan A. Brown Assistant Professor of Physics, Syracuse University, Syracuse. Brown is exploring the universe with gravitational waves: a new frontier in 21st-century astronomy and astrophysics.

Richard Leo Brutchey Assistant Professor of Chemistry, University of Southern California, Los Angeles. Brutchey is researching a generalized synthetic route to nontoxic semiconductor nanocrystals for use in inexpensive solar cells.

Mark Anthony Caprio Assistant Professor of Theoretical Physics, University of Notre Dame. Caprio is researching symmetries in the nuclear many-body problem: conquering the computational scale explosion.

Linda Columbus Assistant Professor of Molecular Physiology and Biological Physics, University of Virginia, Charlottesville. Columbus' work, titled "Hijacking the Hijackers," takes advantage of the chemistry of bacterial pathogens.

Christopher J. Douglas Assistant Professor of Chemistry, University of Minnesota, Minneapolis. Douglas is studying catalytic methods in functionalizing single bonds to carbon.

Joshua S. Figueroa Assistant Professor of Chemistry, University of California, San Diego. Figueroa is researching isocyanide analogues of the unsaturated metal carbonyls.

Austen Lamacraft Assistant Professor of Theoretical Condensed Matter Physics, University of Virginia, Charlottesville. Lamacraft is researching collective phenomena in ultracold atomic gases.

Jennifer Lynn Ross Assistant Professor of Physics, University of Massachusetts, Amherst. Ross is studying microtubule intracellular highways: building bridges between physics and biology.

Kyle Shen Assistant Professor of Physics, Cornell University, Ithaca, NY. Shen is shedding light on quantum interactions in new correlated electronic states of matter.

2010 Cottrell Scholars' Conference

Being a world-class physicist, chemist or astronomer is one thing. Improving science education by changing the culture in a top research university, from an assistant professor's often tenuous vantage point, can be even more challenging. And that was the assignment in July at the 16th Annual Cottrell Scholars' Conference held in Tucson.

Goals of the three-day workshop matched those of RCSA, to promote: early career research; innovations that lead to transformative research; integration of research and undergraduate science education; interdisciplinary and collaborative approaches to research; and building academic cultures that embrace all of these things.

Under the leadership of five senior scientist-educators, the 21 Cottrell Scholars attending the meeting grappled with the beast of institutional resistance to change, under the overall theme of promoting mentorship.

"Motivation is always the hardest part," said keynote speaker Art Ellis, the Vice Chancellor of Research at UC San Diego. To achieve change, Ellis advised "Identifying strategies that allow everyone to feel like they are winning. Ask yourself, 'What will they get out of it?' Then come up with the resources, and the rest will develop."

Beyond stand-and-deliver teaching

Ellis (who became the Provost of the City University of Hong Kong in September) called on the Scholars to reject the old "stand-and-deliver" style of teaching facts without providing insight into how they were obtained. And to demonstrate, he didn't give even a brief lecture before he passed around some "memory metal" sticks, an alloy that once bent will return to its original state when heated. He did what he does with his students—he let participants discover for themselves by dipping the metal in cups of hot water, fueling their curiosity. The demonstration set the stage for a conference that aired many alternatives to the old lecture format, which some conferees jokingly referred to as the "sage-on-a-stage" approach.

Janet L. Hunting, Chemistry
Ithaca College, Ithaca, NY
Conducting Metal Oxides as Stable Catalyst Supports for Fuel Cell Applications

Maki Inada, Chemistry
Ithaca College, Ithaca, NY
Regulation of Gene Expression by Coupling Pre-mRNA Splicing with RNA Decay

Anna M. Courtier, Other
James Madison University, Harrisonburg, VA
Radial Structure and Composition of Mantle Plumes: Implications from Seismic Discontinuities and Travel-times

Horace T. Crogman, Physics
La Sierra University, Riverside, CA
Analysis of Highly Excited Vibrational-Rotational States of Small Polyatomic Molecules in Terms of Classical Relative Equilibria

Elizabeth E. Dahl, Chemistry
Loyola University Maryland, Baltimore, MD
*Production of Alkyl Nitrates by the Marine Diatom Species *Thalassiosira weissflogii* and *Skeletonema Costatum**

Jonathan Bougie, Physics
Loyola University of Chicago, Chicago, IL
Development and Application of Hydrodynamic Models for Granular Media

Brian S. Day, Chemistry
Marshall University, Huntington, WV
A Structure and Function Analysis of Aptamer Monolayers Created from Self-Assembling DNA Dendron Conjugates

Lifeng Dong, Physics
Missouri State University, Springfield, MO
DNA-Templated Synthesis of Pt Nanoparticles on Single-Walled Carbon Nanotubes and Structural Characterizations

Andrew K Udit, Chemistry
Occidental College, Los Angeles, CA
Targeting Sulfated Ligands to Unnatural Amino Acids on Virus Platforms for Generation of Polyvalent Nanoparticles with Heparin-like Activity

Jason A. Bennett, Chemistry
Pennsylvania State University, Erie-Behrend College, Erie, PA
Fundamental Investigation of Electrocatalytic Materials to Promote the Preferential Oxidation of H₂S Over Interfering Gasotransmitters

Catherine A. Sarisky, Chemistry
Roanoke College, Salem, VA
Purine Biosynthesis in Archaea: Variations on a Theme

Amelia A. Fuller, Chemistry
Santa Clara University, Santa Clara, CA
Efficient Identification of Protein Mimics

Guofang Chen, Chemistry
St. John's University, Queens, NY
Light-control Tunable Bio-adhesion at Photo-/thermoreponsive Micropatterned Polymer Film inside Polymeric Microchip

2010 SINGLE-INVESTIGATOR CCSA RECIPIENTS, CONTINUED

Santaneel Ghosh, Physics

Southeast Missouri State University,
Cape Girardeau, MO

*Externally Tunable, Biocompatible,
Multifunctional Nano-carriers for Controlled
Release of Drugs into Neurons*

Jeffrey J. Peterson, Chemistry

SUNY Geneseo, Geneseo, NY

*Correlated Charge and Fluorescence Mea-
surements from Single CdSe Quantum Dots*

Luyi Sun, Chemistry

Texas State University, San Marcos

*Immobilization of Ionic Liquids Using
Layered Materials*

Timothy J. Brunker, Chemistry

Towson University, Towson, MD

*Bistable Chiral Metal Sulfoxide Complexes
as Chiral Molecular Switches*

Jeff R. Simpson, Physics

Towson University, Towson, MD

*Probing Many-Body Physics in Graphene
Devices Using Micro-Raman Spectroscopy*

Holli Frey, Geology

Union College, Schenectady, NY

*Weathering of Volcanic Rocks and their
Influence on Regolith and Water Chemistry
in the Deschutes Basin, Oregon*

Charles R. Sweet, Chemistry

United States Naval Academy, Annapolis,
MD

*Characterization of Lipopolysaccharide
(Endotoxin) in Algae and Cyanobacteria*

Matthew E. Lopper, Chemistry

University of Dayton, Dayton, OH

*Development of Novel Antibacterial
Compounds to Target Bacterial DNA
Replication Restart Pathways*

Ming Yu, Physics

University of Louisville, Louisville, KY

*A Comprehensive Study of the Underlying
Physics in the Interface Induced Electronic
Structure of the Epitaxial Graphene Grown
on SiC*

Michael L. Larsen, Physics

University of Nebraska, Kearney

*Absorption and Scattering in Correlated
Random Media*

Junqiang Lu, Physics

University of Puerto Rico, Mayaguez

*Dynamics Electron Transport in Nanoscale
Structures: Modeling Nanoscale Capacitance*

Rae Anderson, Physics

University of San Diego, San Diego, CA

*Elucidating the Molecular Dynamics,
Conformations, and Interactions Occurring
in Complex DNA Systems via Novel Single-
molecule Techniques*

Aparna Venkatesan, Astronomy

University of San Francisco,

San Francisco, CA

*The Effects of Helium Reionization in the
Early Universe*

In the afternoon, a dozen or so Lego sets were dumped on tables and Scholars were told to form six teams and use the plastic building blocks to translate each team's ideas about the ideal science department into physical spaces without regard to cost.

"What do you want us to do?" one Scholar asked.

"I'm not going to tell you. That's your job," shot back Jeanne Narum. It was part of her keynote presentation called "The Fanciful Horizon." Narum is a national sparkplug for the redesign of spaces for undergraduate science education. She directs the Independent Colleges Office in Washington, D.C., and is founding director of Project Kaleidoscope (PKAL), a network of colleges working to improve science education. PKAL links campus teams around the country to promote efforts to enhance student learning across STEM disciplines.

Soon each group of Scholars had begun building structures to accommodate teaching, faculty offices and networking and mentoring spaces. No two of them were even remotely alike, but all of the teams described ways that design could serve the team's own goals for promoting integrative undergraduate education—and how their goals shifted during the design process.

One intriguing keynote title came from Laurie McNeil, a condensed matter physicist at the University of North Carolina-Chapel: "It's Hard to Lead the Cavalry if You Think You Look Funny on a Horse." She was quoting Adlai Stevenson II. McNeil told the Cottrell Scholars that in order to think big about changing the culture in a department or university, they would first have to think big about themselves. "You are the people our communities will look to for leadership, and not just in science," she said. "You need to think of yourselves as leaders. You may think you look funny on a horse, but start thinking that way."

Approach everything as a scientist

McNeil's invitation to the Scholars to "approach everything you do as a scientist" became one of two watchwords at the conference. The other was her closely related idea: "Don't reinvent the flat tire." As a scientist, McNeil said, you first find out whatever you need to know, then you decide on a course of action. Before you advise a student, listen to the student carefully—"All your students won't grow up to be you." Before you try a push toward change, ask your colleagues to describe their mentoring style. You may get blank looks, but that may be helpful, and in any case you can demonstrate "mindful management" of your own research group. "Be all that you can be. Integrate research and teaching," she said. "Teach like a scientist." That, she said, requires regularly assessing whether you have achieved your specified goals. "This is what we do when

we research,” she said. “We’re not doing that when we teach, we teach as we were taught.”

“All politics is local,” McNeil said, using a phrase made famous by U.S. Representative Tip O’Neill. “The department is the critical unit for change.” You can fly at 30,000 feet as much you want, she said, but change is all about people and process. “Being department chair would be so easy if they had no people in them,” she added.

To personalize her call for leadership, McNeil asked the Scholars to choose one item from a list: research, teaching, applied benefits from science, improving your institution, equal opportunity, public understanding of science or public policy informed by science. Then she showed how any one of them could constitute “a cavalry charge.”

Cultivating new skills of graduate students to embrace collaborative research was the theme of Teri Odom, a 2005 Cottrell Scholar who is now an associate professor of chemistry at Northwestern as well as the Dow Chemical Company Research Professor. Odom, who works on uncovering electronic and optical phenomena at the nanoscale and mesoscale, advised the Scholars that in order to build the innovation and creativity of graduate students, they as professors should require that a student must “present something” to be sent to a conference. “The stakes are higher,” she said. “The student will become ready to take off. Otherwise they will still be gathering data forever.”

Odom is leading a team of faculty at Northwestern University in writing an application for an IGERT (Integrative Graduate Education and Research Traineeships) award from the National Science Foundation. She urged the Scholars to embrace the IGERT criteria stressing interdisciplinary themes, instruction in communicating research to nonscientist audiences, and building a pyramid model with knowledge gathering as a foundation to analysis, synthesis, and evaluation at the top. She said it was crucial for students to achieve a set of “first author” publications to show leadership and second and third author papers to show that they can work as a member of a team. Above all, she said, students should “be good at finishing a project. They must come up with new ideas and execute them. They have to show that they can take initiative.”

Engage in public service

Providing an inside-Washington view of the intersection of science and policy, Seth Cohen, a 2004 Cottrell Scholar and an associate professor of chemistry and biochemistry at UC San Diego, walked the audience through his 2008-2009 year at the U.S. Office of Science and Technology Policy (OSTP), where he was the AAAS Roger Revelle Fellow in Global Stewardship. The OSTP advises the White House, and Cohen worked there during

Wilton Luis Virgo, Chemistry

Wellesley College, Wellesley, MA
Vibrationally Mediated Photodissociation and Velocity Map Imaging to Investigate the Photochemical Mechanisms that Mediate Atmospheric Chemistry

David Duane Evanoff, Jr., Chemistry

Western Carolina University, Cullowhee, NC
Synthesis and Characterization of Silver Core-dielectric Spacer-metal Shell Nanoparticles and their Application to Surface Enhanced Spectroscopy

Kenneth J. Rines, Astronomy

Western Washington University, Bellingham, WA
Probing Dark Energy and Galaxy Cluster Evolution with Optical Spectroscopy

Marion G. Gotz, Chemistry

Whitman College, Walla Walla, WA
Structure-Based Design and Synthesis of Bimodal Proteasome Inhibitors as Therapeutic Agents

David Altman, Physics

Willamette University, Salem, OR
Elucidating the Role Mechanical Forces Play in the Regulation of Myosin Function

David A. Snyder, Chemistry

William Paterson University, Wayne, NJ
Leveraging Protein Homology for Rapid and Robust Molecular Dynamics Calculations

TOP CCSA SCHOOLS

Winning numerous Cottrell College Science Awards over a sustained period demonstrates that institutions have created an environment in which early-career scientists and undergraduate research are both figuratively and literally prized.

With 2010's Awards included, the institutions that have received the most Cottrell College Science Awards in the last 10 years are:

Primarily Undergraduate Universities (5,000+ undergraduates)

	No. of Awards
California State University, Long Beach**	18
Illinois State University	14
Western Washington University*	14
Brock University, Canada***	11
University of Wisconsin-Eau Claire	11
California State University, Northridge	10
James Madison University*	10
University of San Diego*	9
Boise State University	9
University of Minnesota Duluth	9

Liberal Arts Institutions (fewer than 5,000 undergraduates)

	No. of Awards
Franklin and Marshall University	9
Colgate University	8
Hamilton College**	8
University of Richmond	8
College of Holy Cross	7
Harvey Mudd College*	7
Hope College	7
United States Naval Academy*	6
Union College*	6

*received an award this year

**received two awards this year

***Canadian institution, no longer eligible

both the Bush and Obama administrations. Cohen's assignments included the presidential transition, energy, biomedical research and scientific integrity. Cohen, a chemist who works in medicinal bioinorganic chemistry and inorganic materials, drew a contrast between "policy for science," which concerns funding and advancement of innovation, and "science for policy," which puts science to use to inform policy decisions wherever scientific information is pertinent to a public policy issue. Scholars, he said, must take care not to allow science to be politicized, on one hand, and must, as in the global climate debate, keep the science separate from ethical decisions. His keynote talk encouraged scholars to engage in public service, even at the local level—he was a member of the planning commission in his home town, San Marcos, California.

Many of the 2010 conference's PowerPoint presentations are posted at the Research Corporation for Science Advancement web site. If there was one favorite line, it was a quote from Sophocles, around 415 B.C. "One must learn by doing the thing; for though you think you know it, you have no certainty until you try." A close second was from Gandhi: "You have to believe you can cause a breakthrough before you can."

And some of the best mentorship advice to the new professors came from Laurie McNeil: "Be nice to the students. One of the students in my first class is now the provost, my boss." It was a reference to Holden Thorp, since 2008 the chancellor of the University of North Carolina at Chapel Hill.

Real world change

Cottrell Scholars came to the 2010 Conference with stories of change—in both education and their labs—that provided some of the conference's most powerful moments, reflecting how RCSA's goals actually take shape across the country. Two examples:

When his turn came, Keivan Stassun, of the physics and astronomy department at Vanderbilt University, recalled an idea that he submitted in his Cottrell Award application in 2006. He asked Research Corporation for support to continue a new bridge program with Vanderbilt and Fisk University, a historically black campus two miles away in Nashville that was producing master's students in physics. The goal was drawing Fisk's students into Vanderbilt's doctoral programs. So far, he said, the program has admitted 42 students in underrepresented categories, most of them women, with a startling retention rate of 90 percent. Since the national rate of such new doctorates has been near single digits lately, Stassun said, his modest local program could strongly alter the science pipeline. "It will have a game-changing effect," he said. Already the first Ph.D. is a faculty member at Alabama A&M University. Other students who started in the program have gone on to Yale and Chicago.

In his recap of his research, Thorsten Ritz, a 2006 Cottrell Scholar with UC Irvine's physics and astronomy department, outlined stunning results of his Cottrell grant that are likely to reshape the field of biophysics: experiments on a "sixth sense," magnetic sensing in animals. Ritz calls himself a molecular biologist. "We can see how birds use the magnetic field to guide themselves, but how? We know about vision and hearing—using the eye and the ear—but what organ is involved in reading magnetic signals?" he asked. Do animals have a built-in magnetic compass to sense the direction of Earth's magnetic field? And what is the biophysics of all that? Are there iron oxide particles in the beak or the nose? Or eye photoreceptors, proteins that help birds navigate? His work involves protein science, spin chemistry and genetics.

Enhancing the Cottrell Scholar Program

The year 2010 also saw the beginnings of a reinvigoration of RCSA's Cottrell Scholar Awards program. A large proportion of the 250 or so Cottrell Scholars, when polled, have expressed a desire to create a network to share innovative ideas and exchange information on improving undergraduate teaching. RCSA staff also began rethinking the program with an eye to increasing the prestige and national recognition inherent in the award, the ultimate purpose being to amplify the impact of Cottrell Scholars' calls for improving science teaching in U.S. research universities.

Arizona Partners in Science

The Arizona Partners in Science program provides summer research opportunities for high-school science teachers in partnership with faculty members at Arizona universities who are doing advanced research. Awards are in the amount of \$14,000, budgeted over two years. The main goals of this program are to help improve grade 9-12 science education and to increase the number of students who choose to pursue science careers.

RCSA has joined with the M.J. Murdock Charitable Trust in a cooperative venture to bring this program to Arizona. While the Murdock Trust supports opportunities for high-school teachers in the Pacific Northwest, Research Corporation for Science Advancement funds awards in Tucson, Arizona.

The 2010 Partners Awardees are:

Stephen G. Kukolich, University of Arizona and Steve Casper, Catalina Foothills High School: *Microwave Spectroscopy Measurements of Spectra and 3-D Structures of Transition Metal Complexes*

Greg William Doppmann, National Optical Astronomy Observatory and Robert J. Hobbins, Sonoran Science Academy: *Benchmarking the Evolutionary State of Young Stars with Photometric Observations*

Catharine Lynn Smith, University of Arizona and Kevin Kehl, Palo Verde High Magnet School: *Epigenetic Mechanisms in Regulation of Metabolism by Nuclear Receptors*

Brian LeRoy, University of Arizona and Pamela G. Tautz, University High School: *Scanning Probe Microscopy of Graphene*

Konrad Ernst Zinsmaier, University of Arizona and Brenda Lundt, Catalina Magnet High School: *Molecular Mechanisms of Mitochondrial Transport in Axons and Dendrites*

Department Development Awards

The Department Development Awards (DDA) program is designed to assist promising science departments at our nation's colleges and universities to reach the next level of excellence. The program is no longer making awards.

Three DDA awards—at Hamilton College, James Madison University, and the University of San Diego—were still in progress during 2010. Initiated in 2006, the DDA to Hamilton College concluded after an annual visit by RCSA personnel and consultants in September, while awards at James Madison University and the University of San Diego were started in 2008 and both are in the third year of the four-year award period.



DDA San Diego

Campus Visits

Research Corporation for Science Advancement is one of the few independent foundations whose Program Officers make regular visits to mentor faculty and assess the nation's college and university science departments. Campus visits have been an RCSA tradition since the days of founder Fred Cottrell, who was constantly in motion across America, looking for bright, young scientists with potentially transformative ideas.

In 2010 RCSA Program Officers visited 12 colleges and universities. Program officers are extensively engaged in new program development, in particular the Scialog program and enhancements to the Cottrell Scholar program.

The 2010 visits to campuses were focused on institutions in three categories:

- First, we chose institutions with relatively high recent application and award activity in RCSA programs. At these institutions, we worked to identify the factors causing that uptick in activity, in order to provide guidance to other institutions.
- Second, we chose institutions with active or recently closed Department Development Awards, again to assess the impact of those awards on institutional support for science and the production rate of undergraduates majoring in science.
- Third, we visited institutions in which faculty had won multi-disciplinary Cottrell College Science Awards in 2009. The multi-disciplinary program is new, thus we assessed progress and effectiveness at Vassar College, James Madison University and Fairfield University.

Looking Ahead to Our 2012 Centennial

The year 2012 will mark a milestone for Research Corporation for Science Advancement. Our foundation—the second oldest in the country after Carnegie and the first devoted entirely to science—will celebrate 100 years of support for innovative science. RCSA is unique in its 100-year focus on funding high risk/high reward programs, leveraging the synergy that comes from convening groups of adventurous scientists and advocating for a more perfect integration of science and education.

During 2010, plans were already being made to commemorate our centennial with a series of programs and celebrations in Washington, D.C., and other cities. RCSA's Archivist, Dena McDuffie's extensive research on the foundation's history in the context of other contemporary events will result in an informative interactive timeline that will be featured on our web site. Look for this and other details of the centennial celebration in our electronic newsletter or at www.rescorp.org.

INSTITUTIONS VISITED 2010

Baldwin-Wallace University
 Connecticut College
 Denison University
 Fairfield University (MI-CCSA)
 Hamilton College (DDA)
 James Madison University (DDA)
 Otterbein University
 Seattle Pacific University
 Seattle University
 University of San Diego (DDA)
 Vassar College (MI-CCSA)
 Western Washington University (DDA)

Presidential Advisory Committee

Vicki Chandler Chief Program Officer, Science, for the Gordon and Betty Moore Foundation and the University of Arizona's Carl E. and Patricia Weiler Endowed Chair for Excellence in Agriculture and Life Sciences, a Regents' Professor in the departments of Plant Sciences and Molecular and Cellular Biology, and the former Director of UA's Bio5 Institute.

Robert J. Full Chancellor's Professor of Integrative Biology, Goldman Professor for Teaching, University of California, Berkeley. Director of the Poly-P.E.D.A.L. Laboratory (Performance, Energetics and Dynamics of Animal Locomotion).

Brent Iverson Distinguished Teaching Professor and the Raymer Professor of Chemistry and Biochemistry at the University of Texas, Austin. Dr. Iverson's research focuses on the production, characterization, and manipulation of large, functional molecules from three different points of view: antibody and enzyme engineering, artificial macromolecules with defined higher order structure and function, and the chemistry of nucleic acid binding, recognition and modification.

Eric Mazur The Balkanski Professor of Physics and Applied Physics at Harvard University. An internationally recognized scientist and researcher, he leads a vigorous research program in optical physics and supervises one of the largest research groups in the physics department at Harvard.

Elizabeth McCormack McCormack received her bachelor's degree in astronomy and physics from Wellesley College and her Ph.D. in physics from Yale University. In 1995 she joined the faculty at Bryn Mawr College and began a research program in molecular physics with funding from a CAREER award from the NSF. She has published over 30 peer-reviewed articles and has received support for her work from the NSF and NASA throughout her time at Bryn Mawr. In 2005 she was elected a Fellow of the APS.

Randall Murch The Associate Director for Research Program Development, as well as Associate Director for the Center for Technology, Security and Policy, National Capital Region, at Virginia Tech University. He also holds adjunct professorships in the School of Public and International Affairs and the department of plant pathology, and is a Visiting Professor in the department of War Studies, King's College London, UK.

Cherry A. Murray Dean of Harvard University's School of Engineering and Applied Sciences, Murray has led some of the nation's most brilliant scientists and engineers as an executive at Bell Laboratories and the Lawrence Livermore National Laboratory. She also holds the John A. and Elizabeth S. Armstrong Professorship of Engineering and Applied Sciences at Harvard. Murray's RCSA term becomes effective in 2011.

Jeanne L. Narum Founding Director, and currently a Senior Fellow, of Project Kaleidoscope (PKAL), based in Washington, D.C. PKAL is one of the leading advocates in the United States for “what works” in building and sustaining strong undergraduate programs in the fields of science, technology, engineering and mathematics (STEM). Narum is also Director of the Independent Colleges Office in Washington, D.C., an organization that provides services directed toward assisting member institutions to be competitive in the search for grants from federal agencies for faculty and curriculum development and institutional renewal.

David Oxtoby President of Pomona College since July 1, 2003. An internationally noted chemist associated with the University of Chicago for nearly three decades, he served as Dean of Physical Sciences at that institution. At Pomona, he is also a Professor of Chemistry, and as a research chemist he is author or co-author of more than 165 scientific articles on such subjects as light scattering, chemical reaction dynamics and phase transitions. He is also the author of several widely adopted textbooks.

Gregory Petsko The Gyula and Katica Tauber Markey Professor of Biochemistry and Chemistry at Brandeis University. Petsko is a member of the Rosenstiel Basic Medical Sciences Research Center at Brandeis, and became the center’s director in 1994. He is a founding scientist of ArQule, Inc., of Medford, Mass., one of the world’s leading companies in combinatorial chemistry. He is Past-President of the American Society for Biochemistry and Molecular Biology.

Geraldine L. Richmond The Richard M. and Patricia H. Noyes Professor of Chemistry at the University of Oregon. Her research is distinguished by the use of nonlinear optical spectroscopy and computational methods to understand the chemistry that occurs at complex surfaces and interfaces that have relevance to problems in energy production, environmental remediation, atmospheric chemistry and biomolecular surfaces. She is a leader in the development and application of the surface nonlinear optical methods used to make these discoveries. In 1998 Richmond founded an organization called “COACH” to foster the career success of women scientists in academia.

Joaquin Ruiz Dean of the University of Arizona College of Science. Ruiz is a fellow of the Geological Society of America and a fellow of the Society of Economic Geologists. He is a member of the American Geophysical Union, the American Chemical Society, the Geochemical Society, and the National Research Council of the National Academies of Science. His research team addresses problems ranging from the origins of life to present-day climate change.

CONDENSED STATEMENTS OF ACTIVITIES AND CHANGES IN NET ASSETS

YEARS ENDED DECEMBER 31, 2010 AND 2009

REVENUES	2010	2009
Investment Income, Net	\$ 17,911,482	\$ 30,914,472
Total Revenues	17,911,482	30,914,472
EXPENSES		
Grants Approved	4,357,942	4,156,965
Science Advancement	1,375,578	1,315,182
Information and Communications	190,048	225,167
General and Administrative	1,400,942	1,678,241
Fundraising	729,946	388,726
Other	211,121	290,440
Total Expenses	8,265,577	8,054,721
INCREASE IN NET ASSETS	9,645,905	22,859,751
NET ASSETS – Beginning of the Year	121,697,251	98,837,500
NET ASSETS – End of the Year	\$ 131,343,156	\$ 121,697,251

CONDENSED STATEMENTS OF FINANCIAL POSITION

AS OF DECEMBER 31, 2010 AND 2009

ASSETS	2010	2009
Investments	\$ 136,930,127	\$ 136,741,673
Cash and Cash Equivalents	9,660	681,299
Other	2,147,667	2,159,111
Total	\$ 139,087,454	\$ 139,582,083
LIABILITIES AND NET ASSETS		
LIABILITIES		
Grants Payable	\$ 3,501,054	\$ 3,535,259
Line of Credit	–	10,200,000
LBT Liability	1,416,094	1,478,199
Other	2,827,150	2,671,374
Total Liabilities	7,744,298	17,884,832
UNRESTRICTED NET ASSETS	131,343,156	121,697,251
Total	\$ 139,087,454	\$ 139,582,083

BOARD OF DIRECTORS

Patricia C. Barron is Chair of the Board of Directors. She is a Corporate Director and is retired from the position of Clinical Associate Professor at the Leonard N. Stern School of Business, New York University. She is also chair of the RCSA Executive Committee.

G. Scott Clemons is Managing Director of Brown Brothers Harriman & Co. He is a member of the Finance Committee and the Science Advancement Committee.

Peter K. Dorhout is Vice Provost for Graduate Studies and Assistant Vice President for Research at Colorado State University. He is a member of the Science Advancement Committee and the Audit Committee.

James M. Gentile is President and CEO of Research Corporation for Science Advancement. He is a member of the Executive Committee.

Robert B. Hallock is a Distinguished Professor in the Department of Physics at the University of Massachusetts at Amherst. He is Chair of the Science Advancement Committee, a member of the Executive Committee and the Governance and Nominating committees.

Robert Holland, Jr. is an Industry Partner with Williams Capital Partners. He is a member of the Governance and Nominating committees and the Finance Committee.

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Seth Lederman is an Associate Professor at Columbia University and a founder of biopharmaceutical companies including Vela, Targent, Krele and Plumblin Pharmaceuticals. He is a member of the Audit Committee, the Science Advancement Committee and the President's Advisory Council.

Elizabeth McCormack is Dean of Graduate Studies and Professor of Physics at Bryn Mawr College. She is a member of the Science Advancement Committee.

Patrick S. Osmer is Vice Provost for Graduate Studies and Dean of the Graduate School of Ohio State University. He is Chair of the Governance and Nominating committees and a member of the Executive Committee.

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Stuart B. Crampton is Barclay Jermain Professor of Natural Philosophy, Emeritus in the Department of Physics at Williams College.

John P. Schaefer is President of LSST Corporation in Tucson, Arizona. He is a former president of Research Corporation and of the University of Arizona.

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Godat Design, Designer



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