
CLEANTECH&
ADVANCED MATERIALS
PARTNERING CONFERENCE
INVENTORS
INVESTORS
INDUSTRY
SEPTEMBER 27, 2013
COVEL COMMONS
UCLA
Office of
Intellectual Property
& Industry Sponsored
Research

I would like to welcome you to UCLA's Cleantech & Advanced Materials Partnering Conference. UCLA is a leading center for innovative research in the development of technologies that will have lasting impact on the world's long-term needs. We are excited to have you join us for this opportunity to share, first-hand, the continuing efforts to address new challenges for our world as a whole.

The scope and breadth of research at UCLA in this space is impressive, due entirely to our enterprising faculty. The faculty who will be presenting to you today are on the forefront of many important technological developments, including transforming energy efficiency, facilitating the use of renewable resources, and ensuring that the world has access to clean water.

We hope you will appreciate their dedication and ingenuity in pushing scientific boundaries in impactful ways.

In summary, we hope that this event will highlight the tremendous calibre of research at UCLA, and provide a venue for you to connect with our researchers and your peers. We aspire to make this an ongoing event that will open new avenues for creativity and commercialization.

Sincerely,

Brendan Rauw

Associate Vice Chancellor and
Executive Director of Entrepreneurship

CONFERENCE PROGRAM

12:45 pm	Registration
1:30 pm	**Ira Ehrenpreis** – General Partner, Technology Partners Welcome/Keynote Address
2:00 pm	**Industry Panel** – Representatives from Bayer MaterialScience, Boeing Spectrolab, Quallion, Schneider Electric, & Waste Management
2:35 pm	**Investor Panel** – Representatives from Craton Equity Partners, US Renewables Group, & Venable LLP
3:15 pm	**Bruce Dunn** – Materials Science and Engineering (Northridge Room) Topic: Three-Dimensional Battery Architectures
	Gaurav Sant – Civil & Environmental Engineering (West Coast Room) Topic: New Directions Toward Improving Carbon, Energy and Durability Metrics of Cementitious Materials and Concrete Infrastructure
	Ivan Catton – Mechanical and Aerospace Engineering (South Bay Room) Topic: A Designer Fluid for Phase Change Heat Transfer Devices
	Rajit Gadh – Mechanical and Aerospace Engineering (Grand Ballroom "Salon A") Topic: WINSmartEV – The UCLA Smart Electric Vehicle Charging Network Optimized for Customer, EV, Parking Facilities and Grid Usage
3:45 pm	**Qibing Pei** – Materials Science and Engineering (Northridge Room) Topic: Transparent Polymer Composite Conductors: Opportunities for Flexible and Stretchable Thin Film Electronic Devices
	Eric Hoek – Civil & Environmental Engineering (West Coast Room) Topic: Innovations in Water Technology for Desalination, Oil & Gas Production and Waste-to-Energy Applications
	Laurent Pilon – Mechanical and Aerospace Engineering (South Bay Room) Topic: Novel Thermal and/or Mechanical Energy Conversion Using Ferroelectric Materials
4:15 pm	**Larry Carlson** – Institute for Technology Advancement (Northridge Room) Topic: BruinPatch: UCLA and NIST Funding Unite to Create a New Approach to Fixing Our Streets and Highways
	Yoram Cohen – Chemical & Biomolecular Engineering (West Coast Room) Topic: Surface-Nanostructuring with Polymers for Membranes and Chemical Sensors
	Richard Wirz – Mechanical and Aerospace Engineering (South Bay Room) Topic: Green Energy: Solar Thermal, Wind, and Plasma Materials
4:45 pm	**Richard Kaner** – Materials Science and Engineering (Northridge Room) Topic: Graphene Supercapacitors
	James Liao – Chemical and Biomolecular Engineering (West Coast Room) Topic: Exploring Principles of Metabolic Engineering for Fuels and Chemicals Production
	Yu Huang – Materials Science and Engineering (South Bay Room) Topic: Engineering Highly Effectively Nanocatalysts for Fuel-cell Applications and Beyond
5:15 pm	Reception on Terrace

CONTENTS

Larry E. Carlson

Director of Advanced Materials
UCLA Engineering Institute for Technology Advancement (ITA)

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Larry Carlson is Associate Director of the UCLA Engineering Institute for Technology Advancement, and Director of Advanced Materials. He is also the Fund Manager for the Easton Foundation where he focuses on developing new materials for use in the aerospace and sporting goods industries. He serves as Principle Investigator (PI) and co-PI on several privately and government funded programs, including research for the National Institute of Standards and Technology (NIST) and the U.S. Department of Defense (DOD). His current specialty is carbon nanotube-based composites for multifunctional properties.

Prior to joining UCLA in 2009, he spent 20 years at Easton Sports where he was Vice President for Research and Development. Prior to that, he spent 15 years with Alcoa in various engineering management and marketing management roles. He received his B.S. in Mechanical Engineering from Lehigh University and has done graduate work at Lehigh University, the University of Pittsburgh, and UCLA.

Ivan Catton, Ph.D.

Professor of Engineering
Mechanical and Aerospace Engineering

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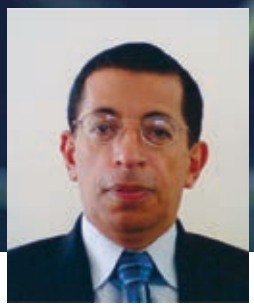
Ivan Catton is Professor in the Mechanical and Aerospace Engineering Department at UCLA. He received his Ph.D. in Engineering from UCLA in 1966. For over 40 years, Ivan Catton has made significant contributions to a wide variety of basic and applied problems in thermal science and engineering, including natural convection, flow instability, solar energy utilization, porous media transport, and nuclear reactor safety. Recently he has developed a new, patent pending heat transfer fluid. Professor Catton has served as Director of the Morin-Martinelli-Gier Memorial Heat Transfer Laboratory since 1984. Catton is a Fellow of both ASME and ANS, and has received an ASME Best Paper Award, the Heat Transfer Memorial Award and the Max Jakob Memorial Award. He has also served as an associate editor of the Journal of Heat Transfer. Professor Catton has published 430 research papers of which 190 are in the archival literature.



Yoram Cohen, Ph.D.

Professor
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Director, UCLA Water Technology Research Center

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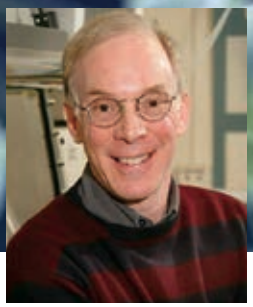
Dr. Cohen is a UCLA Professor of Chemical & Biomolecular Engineering (CBE) since 1981 and Director of the UCLA Water Technology Research Center. He is also on the faculty of the UCLA Institute of the Environment and Sustainability and a UCLA Luskin Scholar. He is a recognized expert in membrane separation processes, surface nano-structuring, graft polymerization, water purification and desalination, and environmental impact assessment, with over 200 published research papers and book chapters in the above areas. He developed patented technologies for smart water treatment and desalination systems, membrane monitoring, surface nano-structured membranes, in addition to software for nanoinformatics and environmental impact assessment. Dr. Cohen and five Faculty co-founders of the UC Center for Environmental Impact of Nanotechnology received the 2012 California Governor's Award in Green Chemistry. He also is recipient of the AIChE Lawrence K. Cecil award in Environmental Chemical Engineering (2003) and the Ann C. Rosenfield Community Partnership Prize (2008) in recognition of his environmental research, and State of California Senate and US Congressional Certificates of Recognition (2008) for contributing to legislation to protect public health.



Bruce Dunn, Ph.D.

Nippon Sheet Glass Professor of Materials Science and Engineering

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Bruce Dunn is the Nippon Sheet Glass Professor of Materials Science and Engineering at UCLA. He was a staff scientist at the General Electric Corporate Research and Development Center before joining UCLA. His research interests concern the synthesis of inorganic materials and characterization of their electrical, optical, biological and electrochemical properties. His recent work on electrochemical energy storage includes research on three-dimensional batteries and pseudocapacitor materials. He has authored or co-authored over 300 papers in scientific and technical journals and has been awarded 13 patents with several others pending. He has received a number of honors and awards including a Fulbright research fellowship, invited professorships and two awards from DOE for his research in materials science. He is a Fellow of both the American Ceramic Society and the Materials Research Society.

Rajit Gadh, Ph.D.

Professor
Director, Smart Grid and Energy Research Center

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Dr. Rajit Gadh is a Professor at the Henry Samueli School of Engineering and Applied Science at UCLA, Founder and Director the Smart Grid Energy Research Center or SMERC (http://smartgrid.ucla.edu) and Founder and Director of the UCLA WINMEC Consortium (http://winmec.ucla.edu). Dr. Gadh has a Doctorate degree from Carnegie Mellon University (CMU), a Masters from Cornell University and a Bachelors degree from IIT Kanpur all in engineering. He has taught as a visiting researcher at UC Berkeley, has been an Assistant, Associate and Full Professor at University of Wisconsin-Madison, and was a visiting researcher at Stanford University.

Eric M.V. Hoek, Ph.D.

Professor & Industrial Affiliates Program Director
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Eric M.V. Hoek is a Professor in the UCLA Department of Civil & Environmental Engineering. His UCLA research group explores the union of nanomaterials and membrane technologies for water, energy, biomedical and environmental applications. In the past decade, he has co-authored over a hundred scientific articles, book chapters, patents and proceedings papers, is a former Editor of the journal Desalination and recently co-edited The Encyclopedia of Membrane Science & Technology for John Wiley & Sons.

Hoek also enjoys applying his basic research knowledge to practical applications having consulted for a range of private companies, law firms, US federal, state and local agencies, private research foundations, NGOs and foreign national research agencies. Dr. Hoek has served as an advisor on major water reuse and desalination projects in Southern California, and has been involved with the formation of several water technology startup companies including NanoH2O (nanoh2o.com) and Water Planet Engineering (wpeh2o.com).

Yu Huang, Ph.D.

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Professor Huang is an Associate Professor in the Department of Materials Science and Engineering at UCLA. She received her B.S. in Chemistry from University of Science and Technology of China and her Ph.D. in Physical Chemistry from Harvard University. Before she joined UCLA, she was a Lawrence Postdoctoral Fellow in Lawrence Livermore National Labs. At UCLA, Professor Huang and her group explore the unique technological opportunities that result from the structure and assembly of nanoscale building blocks. Focusing on the molecular level, she conducts research to unravel the fundamental principles governing nanoscale material synthesis and assembly; and utilizes such principles to design nanostructures and nanodevices with unique functions and properties to address critical challenges in electronics, energy science and biomedicine. Recognitions she received include the World's Top 100 Young Innovators, the Sloan Fellowship, the PECASE, DARPA Young Faculty Award and the NIH New Innovator Award.

Richard B. Kaner, Ph.D.

Distinguished Professor of Chemistry
Distinguished Professor of Materials Science and Engineering

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Richard B. Kaner received a Ph.D. in inorganic chemistry from the University of Pennsylvania in 1984 working with Prof. Alan MacDiarmid (Nobel Laureate 2000). After carrying out postdoctoral research at the University of California, Berkeley, he joined the University of California, Los Angeles (UCLA) in 1987 as an Assistant Professor. He was promoted to Associate Professor with tenure in 1991, became a Full Professor in 1993 and a Distinguished Professor in 2012. He has published over 275 papers in top peer reviewed journals and holds 14 U.S. patents with 20 more pending. Professor Kaner has received awards from the Dreyfus, Fulbright, Guggenheim and Sloan Foundations as well as the Exxon Fellowship in Solid State Chemistry, the Buck-Whitney Research Award, the Tolman Medal and the Award in the Chemistry of Materials from the American Chemical Society for his work on refractory materials including new synthetic routes to ceramics, intercalation compounds, superhard metals, graphene and conducting polymers. He has been elected a Fellow of both the American Association for the Advancement of Science (AAAS) and the Materials Research Society (MRS). Along with appointments in the Departments of Chemistry and Materials Science & Engineering, Professor Kaner served as the Associate Director of the California NanoSystems Institute from 2007-09. Professor Kaner's teaching has been recognized with the Hanson-Dow Award for Excellence in Teaching, the Harriet and Charles Luckman Distinguished Teaching Award and the Gold Shield Faculty Prize for Academic Excellence.

James C. Liao, Ph.D.

Ralph M. Parsons Foundation Professor and Chair
Chemical and Biomolecular Engineering

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Dr. James C. Liao, Ralph M. Parsons Foundation Professor and Department Chair, Chemical and Biomolecular Engineering of UCLA, is a pioneer in Metabolic Engineering. He received his B.S. degree from National Taiwan University and Ph.D. from University of Wisconsin-Madison. After working as a research scientist at Eastman Kodak Company, Rochester, NY, he started his academic career at Texas A&M University in 1990 and moved to UCLA in 1997. He received numerous awards, including Merck Award for Metabolic Engineering (2006), Food, Pharmaceutical, and Bioengineering Division award of American Institute of Chemical Engineers (AIChE) (2006), Charles Thom Award of the Society for Industrial Microbiology (2008), Marvin Johnson Award of American Chemical Society (2009), Alpha Chi Sigma Award of AIChE (2009), James E. Bailey Award of Society for Biological Engineering (2009), Presidential Green Chemistry Challenge Award (2010), and the White House "Champion of Change" for innovations in renewable energy (2012). In 2013, he was elected to the National Academy of Engineering, and was named a co-winner of the ENI Renewable Energy Prize, bestowed by the President of Italy.

Qibing Pei, Ph.D.

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Materials Science and Engineering

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Qibing Pei is Professor of Materials Science and Engineering, UCLA. He specializes in synthetic polymers and composites for electronic, electromechanical, and photonic applications, with over 120 peer-reviewed journal publications. He is the inventor or co-inventor of 39 awarded US patents covering polymer OLEDs, dielectric elastomers with greater than 100% actuated strain, light emitting polymers, and related materials and thin film devices. His current research activities include synthesis of conjugated polymers, stretchable polymer electronics, nanostructured composites, polymer actuators and generators. Dr. Pei received a B.S. degree from Nanjing University, China, and a Ph.D. from the Institute of Chemistry, Chinese Academy of Science, Beijing. He was a postdoctoral scientist in Linköping University, Sweden, a senior chemist 1994-1997 at UNIAX Corporation (now DuPont Display), Santa Barbara, and a senior research engineer 1998-2004 at SRI International, Menlo Park, California. He has been on the UCLA faculty since 2004. He was named a Fellow of the SPIE in 2012.

Laurent Pilon, Ph.D.

Professor
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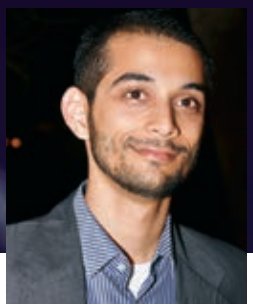
Laurent Pilon is Professor in the Mechanical and Aerospace Engineering Department at UCLA. He received his Ph.D. in Mechanical Engineering from Purdue University in 2002. Professor Pilon's laboratory focuses on synthesizing, characterizing, and modeling materials for waste heat energy harvesting and energy storage applications. In particular, his team has developed patent-pending processes and devices to convert waste heat and/or ambient mechanical energy directly into electricity. Professor Pilon is the recipient of the 2005 National Science Foundation CAREER Award, the 2008 Bergles-Rohsenow Young Investigator Award in Heat Transfer from ASME, and the 2009 Young Scientist Award in Radiative Transfer from the Journal of Quantitative Spectroscopy and Radiative Transfer. He was elected Senior Member of SPIE in 2011.



Gaurav N. Sant, Ph.D.

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Gaurav Sant earned his BSCE (2006), MSCE (2007) and Ph.D. (2009) in civil engineering from Purdue University and spent a post-doctoral year (2010) at the Ecole Polytechnique Federale de Lausanne. Gaurav's research is focused on the development of sustainable materials for infrastructure construction, with special emphasis on reducing the CO_2 and energy use impacts of cement and cement-based derivatives in applications ranging from bridges to buildings. This work which is supported by federal, state and industrial partners leverages both experimental and computational platforms to seek cutting-edge solutions to "material's sustainability concerns" facing the construction industry. The outcomes of this work have been published in over 45 papers in international journals and conference proceedings.

Richard Wirz, Ph.D.

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Richard Wirz is an Assistant Professor in the Mechanical and Aerospace Engineering Department at UCLA and holds a joint appointment in JPL's Electric Propulsion Group. He is the Director of the UCLA Plasma & Space Propulsion Laboratory and the UCLA Energy Innovation Laboratory. His plasma and space related research focuses on advanced propulsion concepts and the plasma science relevant to these devices. His energy research currently focuses on new approaches to solar thermal energy storage and wind energy capture.

UCLA Technologies Available for License

Energy Technologies

Water Technologies by Faculty

Advanced Materials Technologies by Faculty

Energy Technologies
SOLAR

Vertical Heterostructures for Transistors, Photodetectors, and Photovoltaic Devices

Professor Duan and colleagues have developed a vertical field-effect transistor (VFET) that enables high current density through the overall semiconductor area with a high on-off current ratio. Current densities reach 2–5 orders of magnitude greater than those recently reported for vertical tunneling transistors or barristors. Integrating graphene with solution-processible semiconductor materials to form vertically-stacked devices can lead to new types of low-cost, high-performance transistors, photodetectors, and solar cells.

UCLA Case No. 2013-363
Lead Inventor: Xiangfeng Duan
Patent Status: *Pending*
Energy| solar, Materials| manufacturing

Hydrogen Production by a Novel Thermochemical Water Splitting Cycle

Professor Manousiouthakis and colleagues have developed a thermochemical cycle for decomposing water into hydrogen and oxygen. There are many realizations of this process involving a variety of intermediates. Thermal decomposition of water usually requires temperatures greater than 2,000° C. This novel thermochemical cycle can be operated at a relatively low temperature of ~900° C. Due to its lower operating temperatures, the decomposition can be powered by a variety of energy sources, including solar energy. The innovation lies in the optimization of intermediates, operating temperatures, kinetics, heat removal and control of the rate of reaction, and electricity cogeneration.

UCLA Case No. 2005-332
Lead Inventor: Vasilios Manousiouthakis
Patent Status: *Issued* – #7,960,063
Energy| solar| thermo/pyroelectrics

Improved Photovoltaic Efficiency in Semiconducting Polymer/Fullerene Solar Cells through Control of Fullerene Self-Assembly and Stacking

Professor Tolbert and colleagues have identified a self-assembly method for arranging fullerene molecules that results in a 4X increase in solar cell energy conversion efficiency (current density; on average). This technique allows more control over the packing of individual molecules to provide for higher material densities that result in improved efficiency.

UCLA Case No. 2008-662
Lead Inventor: Sarah Tolbert
Patent Status: *Pending* – Published Application #20090266416
Energy| solar, Materials

Carbon Nanotube/Nanowire Thermo-Photovoltaic Cells

Professor Wang and colleagues have developed three types of thermo-photovoltaic (TPVs) cell structures based on a particular nanomaterial. The optical and electrical properties of these nanotechnology-based TPVs can be tuned during fabrication. This makes them suitable for applications such as waste heat harvesting in industrial manufacturing facilities, high performance-low radiation devices for space applications, and other devices for next-generation electrical conversion.

UCLA Case No. 2005-603
Lead Inventor: Kang Wang
Patent Status: *Issued* – #7,985,615
Energy| solar| thermo/pyroelectrics, Materials| manufacturing

Nanoparticle Hybrid Solar Cell Based on a Copolymer Self Assembly Process

Professor Wang and colleagues have devised of a practical, low cost, large-scale production method for multilayered photovoltaic device fabrication. Hybrid solar cells based on nanocrystals and nanoparticles require high temperature and are expensive to produce. In this technology, UCLA researchers developed a copolymer template to form the nanoparticle array, which offers versatility in construction and low cost compared to conventional thermal annealing and chemical synthesis methods. The approach obviates the need for high temperature, which offers advantages for mass production. The technology has wide applications for portable devices, displays, modulators, detectors, LEDs, and power stations.

UCLA Case No. 2011-206
Lead Inventor: Kang Wang
Patent Status: *Patent Pending*
Energy| solar

A Stretchable Organic Solar Cell Based on Semi-Metal Graphene/Polymer Hybrid

Using hybrid polymeric composites and semi-metal graphene electrodes, UCLA researchers have developed a stretchable solar cell that could be used to conform to various uneven surfaces. The technology has broad applications to consumer goods — including portable electronics and clothing – and infrastructure development for both urban and rural areas.

UCLA Case No. 2010-670
Lead Inventor: Kang Wang
Patent Status: *Patent Pending*
Energy| solar

Polarizing Photovoltaic Device and Its Application in Liquid Crystal Displays and Tandem Solar Cells

Professor Yang and colleagues have developed an energy recycling technology called polarizing organic photovoltaics, which can boost the function of the LCD by working simultaneously as a polarizer, a photovoltaic device, and an ambient light or sunlight photovoltaic panel. urning polarizers into energy-generating photovoltaic units recovers energy from photons which would be otherwise lost. Compared with their silicon or other inorganic or organic-inorganic hybrid counterparts, a unique advantage of the organic conjugated materials is that the molecular chains can be easily reoriented.

UCLA Case No. 2010-666
Lead Inventor: Yang Yang
Patent Status: *Pending*
Energy| solar| thermo/pyroelectrics

Solution Synthesis and Deposition of Kesterite Copper Zinc Tin Chalcogenide Films from Earth Abundant Elements for Solar Cell Applications

Professor Yang and colleagues have developed a solution based method for Cu_2ZnSnS_4-precursor synthesis. Compared to currently-implemented methods, this method is more environmentally friendly, cheaper to execute, and provides a powerful tool for depositing uniform films in chemical compositions suitable for large scale solar cell fabrication.

UCLA Case No. 2011-410
Lead Inventor: Yang Yang
Patent Status: *Pending*
Energy| solar, Materials| manufacturing

Conjugated Low-Bandgap Polymer for Electronic Devices

Organic photovoltaic devices provide an opportunity to utilize solar energy efficiently and at low cost. To harvest a greater spectrum of light, scientists have sought to reduce the energy bandgap of the active material. UCLA researchers have developed a novel low-bandgap polymer that provides excellent photovoltaic performance in single junction devices (PCE >7%). This technology has application to organic solar cells, tandem solar cells, transparent solar cells, field-effect transistors, near infrared (NIR) organic photo-detectors, and NIR organic light emitting diodes, among others.

UCLA Case No. 2013-071
Lead Inventor: Yang Yang
Patent Status: *Pending*
Energy| solar, Materials

An Approach to Deposit a Cd-Free Buffer Layer for CZTS Solar Cells

Cu_2ZnSnS_4 (CZTS) absorber materials point the way to the next generation of thin film solar cells for both ecologically and economically sustainable photovoltaics. However, current n-type emitters or buffer layers, contain cadmium sulfide (CdS), a probable human carcinogen shown to be toxic. UCLA scientists have developed a Cd-free buffer layer on CZTS, which previously has been challenging due to a substantial conduction band offset between CZTS and CdS substitutes. To date, the research team has developed Cd-free photovoltaic devices that have achieved conversion efficiencies over 3.5%.

UCLA Case No. 2013-584
Lead Inventor: Yang Yang
Patent Status: *Pending*
Energy| solar

Multiple Donor/Acceptor Bulk Heterojunction Solar Cells

Professor Yang and colleagues have developed a new device structure for organic photovoltaics that expands the absorption bandwidth and increases overall device performance of the organic solar cells. In contrast to multiple junction solar cells, the approach does not require further fabrication steps, thereby mitigating increases in manufacturing cost and complexity.

UCLA Case No. 2013-919
Lead Inventor: Yang Yang
Patent Status: *Pending*
Energy| solar

Energy Technologies
ALTERNATIVE FUELS

Dieselzymes: Directed Evolution of a More Stable and Methanol Tolerant Lipase for Biodiesel Production

Professor Bowie and colleagues have developed a highly stable and methanol tolerant lipase. The engineered lipase (Dieselzyme 4) has 30-fold increased stability over the wild type enzyme at 50° C and 50-fold increased stability at high methanol concentrations. The improved methanol tolerance, thermostability, and longevity of Dieselzyme 4 make it easily the most robust lipase currently available for biodiesel production. Unlike many other lipases, Dieselzyme 4 is easily expressed in *E. coli*, allowing for simple large-scale production.

UCLA Case No. 2013-299
Lead Inventor: James Bowie
Patent Status: *Pending*
Energy| alternative fuels

A Controllable and Robust Cell-Free System for Fatty Acid Production

Professor Ho and colleagues have developed a system that can produce a large amount of fatty acids in short periods of time. The unique approach has the advantage of not relying on expression systems or living cells, thereby reducing expenses and the overall complexity of the system. The researchers have documented that the production rate of fatty acids is an order of magnitude higher than that of traditional cell culture-based systems. Fatty acids have a great variety of use in the health and cosmetic industries and are a well-characterized precursor to biodiesel and other industrial chemicals.

UCLA Case No. 2013-833
Lead Inventor: Chih-Ming Ho
Patent Status: *Pending*
Energy| alternative fuels

Energy Technologies
STORAGE SYSTEMS

High Capacity Silicide-Air Primary Batteries

Professor Duan and colleagues have developed a novel group of silicide-air batteries. This new class of batteries enjoys several benefits of silicide materials, including high electron capacity, high conductivity, high operating voltage, high earth abundance, and potential environmental benignity; all of which make for an excellent ultra-high density energy storage material. Further developments in oxygen reaction catalysts and tri-electrode cell configurations will enable silicide-air batteries with superior anode capacity and high practical energy density, appropriate for mobile power applications.

UCLA Case Nos. 2012-212, 2014-073
Lead Inventor: Xiangfeng Duan
Patent Status: *Pending*
Energy| storage

Charge Storage Device Architecture for Increased Energy and Power Density

Professor Dunn and colleagues have developed a method that significantly increases the energy density of electrochemical capacitors. High surface area and facile ion motion is attained through fabricating nano-crystalline films with three-dimensionally interconnected porosity. As a result, the charge capacity is increased, without compromising the high charging/discharging rates of electrochemical capacitors.

UCLA Case No. 2009-392
Lead Inventor: Bruce Dunn
Patent Status: *Pending* – Published Application #20120026644
Energy| storage systems

Membraneless Fuel Cell with Self-Pumped Fuel and Oxidant

Professor Kim and colleagues have developed a fuel cell that incorporates an innovative membraneless design with other specialized ancillary technologies to simplify the device and enable miniaturization to the millimeter scale. Where most fuel cells require ancillary fuel and oxidant pumps, this invention incorporates a previously developed self-pumping mechanism that uses bubbles to move fluids through its channels. Because the system was essentially designed like a solid-state device, it is scalable to large systems and mass production.

UCLA Case No. 2010-309
Lead Inventor: Chang-Jin Kim
Patent Status: *Pending* – Published Application #20120148931
Energy| storage systems| alternative fuel

Carbon Nanotube/ V_2O_5 Composites for Supercapacitors

Professor Lu and colleagues have created a nanocomposite material that vastly improves the charge storage capability of the EC supercapacitors. The unique composite consists of vanadium pentaoxide nanowires (VNW) with varying amounts of carbon nanotube (CNT)-supported vanadium pentaoxides. This unique CNT-VNW structure achieves higher specific energy, higher specific power, and enhanced electrochemical capacitance for supercapacitor applications. Furthermore, the CNT-VNW composite structure imparts higher capacitance than either CNT or VNW alone.

UCLA Case No. 2009-058
Lead Inventor: Yunfeng Lu
Patent Status: *Issued* – #8,427,813
Energy| storage systems, Materials| composites| polymers| nano

Gas Fill-Up Process System and Methodology with Minimum and/or No Cooling

Professor Manousiouthakis and colleagues have developed a novel system and method of filling-up gas into storage vessels. An important lineup of applications includes the fill-up of gases used for energy, such as hydrogen and natural gas. The technology speeds up the fill-up process without compromising safety, and eliminates the need for an expensive cooling system commonly employed by current systems. The proposed methodology also allows the temperature of both the gas and the vessel itself to be controlled by the user.

UCLA Case No. 2014-054
Lead Inventor: Vasilos Manousiouthakis
Patent Status: *Pending*
Energy| storage systems| alternative fuels

Advanced Cascade Thermal Storage

Professor Wirz and colleagues have developed a method to optimize thermal energy storage (TES). By cascading the storage medium (SM), the method optimizes the interaction between the SM and the source/ sink working fluid. For particular SMs, in which pressure and temperature considerations are especially important, this technology promises to yield much higher efficiencies and performance at low cost.

UCLA Case No. 2011-601
Lead Inventor: Richard Wirz
Patent Status: *Pending*
Energy| storage

Supercritical Thermal Energy Storage

Professor Wirz and colleagues have developed a novel method to store thermal energy. The technology enables thermal energy to be stored at significantly higher energy densities, compared to sensible heat storage. Preliminary calculations indicate that energy stored per unit mass can increase 9-fold over storage in saturated liquid. Commercial applications include energy storage in solar power plants, and waste heat recovery in automobiles and industrial plants.

UCLA Case No. 2014-071
Lead Inventor: Richard Wirz
Patent Status: *Pending*
Energy| storage

High-Density, High-Temperature Thermal Energy Storage and Retrieval

Professor Wirz and colleagues have developed a novel, high density, thermal energy storage (TES) system. Instead of using storage materials typically used for TES, like nitrate salts and oils, the current technology utilizes simple, low-cost fluids. Besides being highly available and low-cost, these fluids also afford extremely high thermal stability, as well as the potential to achieve high values of heat capacity. This technology could become the basis for an economical thermal energy storage vessel, thereby reducing a significant capital cost in advanced energy solutions.

UCLA Case No. 2014-102
Lead Inventor: Richard Wirz
Patent Status: *Pending*
Energy| storage

Energy Technologies SMARTGRID

Architecture and Level 2 Variable Power Control Scheme

Professor Gadh and colleagues have developed improved energy control schemes to manage electric vehicle (EV) charging. These systems will provide a more economical, safe, and energy-efficient scheme towards implementing the EV into local power grids, while satisfying customer needs and preferences. In addition, from the schedules of individual EV owners, novel methods of user information recognition will further optimize the power current through an EV.

UCLA Case No. 2013-146
Lead Inventor: Rajit Gadh
Patent Status: *Pending*
Energy| smartgrid| alternative fuels

WinSmartEV: Smart EV Charging and Grid Integration

Professor Gadh and colleagues have developed WinSmartEV, a platform for smart charging and backfill of electric vehicles (EVs). It leverages the UCLA-developed Reconfigurable Wireless Interface for Networking of Sensors technology to integrate with the Smart Grid in order to simultaneously meet the demands of end users and utilities. So, instead of simply adding power capacity, which would be prohibitively expensive, the WinSmartEV platform aggregates charge information statuses from vehicles with demand response signals to automatically achieve grid-to-vehicle charging or vehicle-to-grid back-charge.

UCLA Case No. 2010-903
Lead Inventor: Rajit Gadh
Patent Status: *Pending* – Published Application #20130179061
Energy| smartgrid| alternative fuels

Energy Technologies WIND

High-Strength Wind Turbine Blades and Wings

Perry Johnson and colleagues have developed a novel blade design that optimizes both aerodynamic performance and structural strength in wind turbines. The blade design can minimize airfoil thickness, optimizing aerodynamic and power performance, while the blade gap greatly improves the bending moment of inertia of the inboard region and strength of the overall structure. This invention may also be industrially applied to the manufacture and use of fluid turbine blades, airplane wings, pumps, and propellers.

UCLA Case No. 2012-752
Lead Inventor: Perry Johnson
Patent Status: *Pending*
Energy| wind

Energy Technologies THERMO/ PYROELECTRICS

Thermal Mechanical Energy Harvesting

Professor Carman and colleagues have developed a novel energy harvesting apparatus that may include a ferromagnetic material and/or a shape memory alloys to convert thermal energy to mechanical energy to electrical energy. The apparatus is subjected to a thermal gradient to cause beams to bend, thus creating stress/strain in a piezoelectric material, or creating magnetic flux in a magnetic path. The charges created in this process can be transferred to electrical batteries.

UCLA Case No. 2006-381
Lead Inventor: Gregory Carman
Patent Status: *Issued* – #7,800,278
Energy| thermo/pyroelectrics

Direct Conversion of Nanoscale Thermal Radiation to Electrical Energy Using Pyroelectric Materials

Professor Pilon and colleagues have developed a novel way to harvest waste heat by combining thermal radiation at the nanoscale with pyroelectric energy conversion. This could be used to recover energy from mobile electronic devices, increase efficiencies in power plants, or provide power to remote sensors, among many other applications.

UCLA Case No. 2010-532
Lead Inventor: Laurent Pilon
Patent Status: *Pending* – Published Application #20110298333
Energy| thermo/pyroelectrics, Materials| heat management

Thermochemical Cycle for Thermal and/or Mechanical Energy Conversion Using Ferroelectric Materials

Professor Pilon and colleagues have developed a new energy cycle that converts thermal and/or mechanical energies directly into electrical energy. With the ability to harvest waste heat, the cycle could be used to increase the efficiency of systems like internal combustion engines, heat pumps, and refrigeration systems. Mechanical energy harvesting could be used to salvage energy from roads and various transportation systems. This new cycle can generate energy at temperatures below 200° C, where few energy technologies can operate.

UCLA Case No. 2013-637
Lead Inventor: Laurent Pilon
Patent Status: *Pending*
Energy| thermo/pyroelectrics

Observation of Nuclear Fusion Driven by a Pyroelectric Crystal

Professor Putterman and colleagues have developed a method for generating fusion under desktop conditions. By using the extremely large electric fields produced during the heating of a pyroelectric crystal, deuterium ions accelerate into collisions that generate the fusion. This method can be implemented into electrostatic

fusion devices, palm-sized neutron generators, or even microthrusters for miniature spacecraft.

UCLA Case No. 2005-363
Lead Inventor: Seth Putterman
Patent Status: *Issued* – #8,396,181
Energy| thermo/pyroelectrics| alternative fuels

Triboelectric Photoelectron Accelerator

Professor Putterman and colleagues have developed a low voltage, compact source of high-energy electromagnetic radiation. This accelerator utilizes triboelectricity to produce a strong electric field, which is then seeded with electrons from a distinct, second material. The design of the accelerator circumvents a limitation seen in mechanoluminescent X-ray generators where the electron current is restricted after separation of the electron-donating polymer. The photoelectron accelerator has potential application in fusion reactions, medicine, isotope manufacture, X-ray generation, and pulsed X-ray generation for X-ray movies.

UCLA Case No. 2012-105
Lead Inventor: Seth Putterman
Patent Status: *Pending*
Energy| thermo/pyroelectrics

Energy Technologies
HEAT MANAGEMENT

Low-Temperature Conduction-Cooling of a High-Temperature Superconducting Cable

Professor Manousiouthakis and colleagues have developed a technology that eliminates the need to pump liquid nitrogen throughout the entire length of a superconducting cable. Eliminating the need to pump liquid nitrogen eliminates the associated cost and reliability issues. The innovation involves cooling the cable at periodic lengths and removing heat through a highly conductive copper cladding.

UCLA Case No. 2003-469
Lead Inventor: Vasilios Manousiouthakis
Patent Status: *Issued* – #7,748,102
Energy| heat management

Water Technologies

A Novel *Ex-Situ* Scale Observation Detector (EXSOD) for RO Process Monitoring

Professor Cohen and colleagues have developed a detector that monitors membrane scaling in real time, enabling timely anti-scaling measures to be enacted before irreversible membrane damage. The innovation consists of a specially designed plate-and-frame high pressure RO membrane cell with optical windows. Pressure, feed and permeate flow rates, conductivity and pH are continuously monitored, with data collected by computerized data acquisition systems and displayed in real-time as well as stored for off-line analysis.

UCLA Case No. 2006-408
Lead Inventor: Yoram Cohen
Patent Status: *Issued* – #7,910,004
Water| membranes| filtration

Graft Polymerization Induced by Atmospheric Pressure Plasma

Professor Cohen and colleagues have developed a novel process for surface modification of a broad range of inorganic surfaces via atmospheric plasma-induced graft polymerization. The process utilizes atmospheric gas plasma for surface activation with subsequent graft polymerization of the desired vinyl monomers. The presence of the grafted polymer chains on the substrate was confirmed by infrared spectroscopy. Additionally, surface topology and surface feature uniformity was evaluated by atomic force microscopy (AFM).

UCLA Case No. 2006-661
Lead Inventor: Yoram Cohen
Patent Status: *Pending* – Published Application #20100035074
Water| membranes| filtration

Fouling and Scaling Resistant Surface Nano-Structured Membranes

Professor Cohen and his research team have developed a novel class of membranes capable of resisting organic- and biofouling, as well as mineral salt scaling. These novel membranes have applications in water treatment and desalination, where biomaterial buildup and salt scaling of reverse osmosis membranes represent major impediments to high recovery rates.

UCLA Case No. 2008-736
Lead Inventor: Yoram Cohen
Patent Status: *Issued* – #8,445,076
Water| filtration| membranes, Advanced Materials

Highly Sensitive and Selective Nano-Structured Grafted Polymer Layers for Chemical Sensors

Professor Cohen and his research team have developed methods to synthesize a highly selective thin polymeric film sensing layer composed of a highly dense, covalently and terminally bound nano-structures polymer layer with significantly higher sorption capacity and solute diffusivity relative to existing polymeric sensing layers. The sensing layer can be engineered for hydrophilic, hydrophobic, polar, non-polar, and ionic sensing by choosing appropriate reaction precursors. These layers may be employed on a range of transducers, such as mass, conductive, optic, acoustic, pressure, spectroscopic, and mechanical.

UCLA Case No. 2008-744
Lead Inventor: Yoram Cohen
Patent Status: *Pending* – Published Application #20090311540
Water| filtration| membranes, Materials| polymers

Method and System for High Recovery Water Desalting

Professor Cohen and colleagues have developed a method and system to continuously, sustainably, and inexpensively desalinate high salinity water of high mineral scaling propensity. The system is able to process waters as contaminated as industrial, agricultural, and mining wastewaters, with recovery levels in excess of 90–95%.

UCLA Case No. 2008-787
Lead Inventor: Yoram Cohen
Patent Status: *Pending* – Published Application #20110155665
Water| filtration

Integrated Ultrafiltration and Reverse Osmosis Process and System

Professor Cohen and colleagues have developed a compact and self-adaptive integrated water ultrafiltration and reverse osmosis (UF/RO) process and system. Designed to produce up to 18,000 gallons of drinking quality water per day with no intermediate tanks between UF and RO or for UF backwash, the system can be further expanded for even larger capacity. In addition, the system is remotely monitored and is self-adaptive, making use of advanced model-based control.

UCLA Case No. 2011-138
Lead Inventor: Yoram Cohen
Patent Status: *Pending*
Water| filtration| membranes

Real-Time Integrity Monitoring of Reverse Osmosis Membranes

Professor Cohen and his research team have developed a Membrane Integrity Monitoring (MIMo) system and approach to monitor the integrity of reverse osmosis membranes in real-time. By utilizing automated marker injection and high sensitivity detection, this monitoring system can detect integrity breaches and their severity, and assess the potential passage of various pathogens and contaminants of concern. In addition to providing marker detection down to the part-per-billion level, the marker used in the approach is FDA-approved, non-toxic and economic to use for routine integrity testing. The MIMo system can be deployed in any situation that used reverse osmosis membranes to purify water, including seawater desalination, wastewater treatment, and decontamination of impaired waters.

UCLA Case No. 2013-917
Lead Inventor: Yoram Cohen
Patent Status: *Pending*
Water| filtration| membranes

High Rate Recirculating Hybrid Trickle-Bed Wetland for Graywater Treatment and Reuse

Professor Cohen and colleagues have developed a graywater treatment system to recycle water that presents a number of advantages over currently available systems. It allows water to be re-circulated continuously at a higher flow rate than current systems without flooding, while still providing an aerobic environment in the "soil" layer. Several novel components, including the vegetation support and plumbing are designed to be easily removed, facilitating ease of maintenance and repair. In addition, a number of features prevents clogging in the system. This system has the potential to be low in capital and operational costs, low in maintenance, easy to operate, reliable, and integrated astatically within natural surroundings. A prototype has already been built and operated successfully in the field.

UCLA Case No. 2014-057
Lead Inventor: Yoram Cohen
Patent Status: *Pending*
Water| filtration

Nano-Structured Membranes for Engineered Osmosis Applications

Professor Hoek and colleagues have developed novel nano-structured membrane materials to be used in osmosis-driven separations. Compared to the only commercially-available osmotic membrane, a first-generation form of the technology exhibited ~200 times greater water permeability with similar separation performance; a remarkable early performance benchmark. This membrane has potential applications in forward osmosis water purification, osmotic water samplers, food and beverage dehydration, and salinity gradient energy production.

UCLA Case No. 2010-004-2
Lead Inventor: Eric Hoek
Patent Status: *Pending* – Published Application #20130105395
Water| membranes| filtration, Energy| alternative fuels, Materials| polymers| nano

Sensors for Detecting Membrane Fouling and Degradation at Full-Scale Installations

Professor Hoek and colleagues have developed low and high pressure fouling detectors to be used in full-scale membrane filtration and desalination plants. Successfully tested at the Long Beach Water Department's prototype membrane desalination facility, the detectors represent the inlet of the lead element of a full-scale plant, where fouling is typically most severe, or the outlet of the tail element of a full-scale plant, where scaling occurs. This is crucial, as early warning of membrane fouling, scaling or degradation can result in faster response times to optimize plant performance and/or prevent plant failures.

UCLA Case No. 2010-736
Lead Inventor: Eric Hoek
Patent Status: *Pending*
Water| membranes| filtration

Exploring New Chlorine-Tolerant Polyamide Derivatives for Preparing Biofouling-Resistant RO Membrane

Professor Hoek and colleagues have developed a novel reverse osmosis (RO) membrane formulation that is chlorine tolerant and extremely hydrophilic, which imparts significantly better biofouling resistance in application like desalination and water reuse. These new RO membranes could be packaged for use in new and existing RO water treatment plants, where they could reduce overall energy demand and cost of operation.

UCLA Case No. 2013-455
Lead Inventor: Eric Hoek
Patent Status: *Pending*
Water| membranes| filtration

A Universal, Scalable, and Cost-Effective Surface Modification for Anti-Fouling Polymeric Materials

Professors Kaner and Hoek have led the development of a novel surface modification of plastic materials including polymeric thin films used for medical, optical, sensing and separation applications that provides robust resistance to bacterial adhesion, fouling

and infection. The technology provides a facile method of making anti-infection and anti-fouling plastic surfaces. The unique chemical modification technique can be performed in aqueous solutions and in very short reaction times (seconds to minutes) suggesting it to be amenable to economical commercial scaleup.

UCLA Case No. 2013-504
Lead Inventors: Richard Kaner and Eric Hoek
Patent Status: *Pending*
Water| membranes| filtration|

Materials Technologies

Enhanced Strength Carbon Nanotube Yarns

Professor Carlson and colleagues have developed a novel, chemically functionalized, carbon nanotube yarn. By infusing a resin having sub-nanometer rings, the inventors have created a new material capable of producing the world's strongest carbon fiber, well in excess of 7 GPa.

UCLA Case No. 2011-132
Lead Inventor: Larry Carlson
Patent Status: *Issued* – #8,470,946
Materials| polymers| nano

Wideband Metamaterials from Composites Multiferroics

Professor Carman and colleagues have developed novel wide band materials from composite multiferroics. By combining piezoelectric and piezomagnetic layers of material in the proper materials orientation, negative effective permittivity and negative effective permeability can be realized. This is the basis of a metamaterial that can be used for various electromagnetic wave processing applications such as antennas, filters and lensing.

UCLA Case No. 2013-629
Lead Inventor: Gregory Carman
Patent Status: *Pending*
Materials| composites| electronics

Controlled Nano-Doping of Ultra-Thin Films

Professor Chang and colleagues have developed a method to grow a thin, doped copper layer or alternating stacks of doped copper and undoped copper via atomic layer deposition (ALD) in high aspect ratio, and at low deposition temperatures. The copper dopant precursors can either be Ca, Mg or Zn halides or organometallics. ALD deposition is compatible with low-k dielectrics with typical processing temperatures of 350° C or less.

UCLA Case No. 2003-317
Lead Inventor: Jane Chang
Patent Status: *Issued* – #7,544,398
Materials| manufacturing| nano| electronics

Wafer-Scale Formation of Aligned Nanowires and Nanotubes

Professor Chui and colleagues have developed a method to form aligned nanowires (and/or nanotube arrays) through standard lithographic patterning techniques. The invention enables control over the nanowire (or nanotube) number, linewidth, and pitch, with no restriction on the substrate size and the material choice of nanowires (or nanotubes). Furthermore, since the technique requires a low-thermal budget, integration and fabrication of heterogeneous devices is feasible with minimal cross-contamination issues.

UCLA Case No. 2009-650
Lead Inventor: Chi On Chui
Patent Status: *Pending*
Materials| manufacturing| nano| electronics

Highly Flexible Macroelectronics from Scalable Vertical Thin Film Transistors

Professor Duan and colleagues have developed a new design of highly scalable and flexible vertical thin-film transistors (VTFTs) based on the heterostructure of graphene and amorphous indium gallium zinc oxide (α-IGZO) thin film. Unlike conventional planar TFTs, vertical current flow in VTFT is largely unaffected by an in-plane crack, thus enabling highly robust flexible electronics with superior electrical and mechanical performance.

UCLA Case No. 2013-577
Lead Inventor: Xiangfeng Duan
Patent Status: *Pending*
Materials| manufacturing| electronics

Physical Assembly Integration of Graphene and Dielectrics

Professor Duan and colleagues have developed new strategies for fabricating graphene-based transistors, opening a new route to high performance graphene electronics. This development has broad impacts, from highly integrated circuits, to ultra-sensitive biosensors, to a new generation of spintronics and magneto-electronic devices.

UCLA Case No. 2010-589
Lead Inventor: Xiangfeng Duan
Patent Status: *Pending*
Materials| composites

Cleaning Lithium to Improve Protective Layer

Professor Dunn and colleagues have developed a method to improve the homogeneity of a protective layer placed upon a lithium metal surface. By removing surface impurities from the lithium and applying a uniform protective layer, a more homogenous current distribution can be maintained across the electrode and dendrite formation can be suppressed.

UCLA Case No. 2009-511
Lead Inventor: Bruce Dunn
Patent Status: *Pending* – Published Application #20100221611
Materials| manufacturing| electronics

Novel Composite Semiconductor Substrate for Thin-Film Device Transfer

Professor Goorsky and colleagues have identified a high quality composite semiconductor substrate for epitaxial deposition of electronic device layers that is also capable of transferring device layers from the composite substrate to another substrate of choice. This technique reduces costs associated with having to replace starting materials, and can also be extended to a variety of semiconductor material combinations to create transfer-ready semiconductor substrates. This transfer substrate and process will be useful for any thin film semiconductor device manufacturer.

UCLA Case No. 2008-550
Lead Inventor: Mark Goorsky
Patent Status: *Pending* – Published Application #20110221040
Materials| manufacturing| electronics

Transparent and Flexible Carbon Nanotube Transistors

Professor Grüner has developed a technology that addresses the needs for a flexible and transparent transistor by replacing one or more of the four basic components of a transistor (source, drain, gate, and conduction channel) with a carbon nanotubes network. Since three components of the device are all formed from the same material, the method of fabrication is easy and uses standard fabrication techniques.

UCLA Case No. 2005-432
Lead Inventor: George Grüner
Patent Status: *Pending* – Published Application #20100127241
Materials| polymers| manufacturing| nano| electronics

Flexible Nanotube Transistors

Professor Grüner and colleagues have developed films of nanostructures that can be integrated into flexible semiconducting substrates. This technology has applications in flexible displays, wearable electronics, intelligent paper, and other lightweight, low-cost electronics.

UCLA Case No. 2006-654
Lead Inventor: George Grüner
Patent Status: *Issued* – # 8,456,074
Materials| composites| polymers| nano| electronics

Interconnected Networks of Graphene and Nano-Scale Materials

Professor Grüner and colleagues have developed methods of producing novel, interconnected networks of nano-scale carbons and new forms of high surface area materials with significant electrochemical activity. These new composites can be used as electrodes for energy storage devices, taking advantage of the high conductivity of and the high specific capacitance of the component materials, leading to energy storage with both high energy and power density.

UCLA Case No. 2011-099
Lead Inventor: George Grüner
Patent Status: *Pending*
Materials| composites| polymers| nano| electronics

Aligned Nanowire-Oxide Nanoparticle Composite Electrodes

Professor Grüner and colleagues have invented a novel electrode architecture that incorporates aligned carbon nanotubes decorated with oxide nanoparticle composites. This allows for the high energy capacity and high power density needed to meet the energy storage capacity required in many batteries and supercapacitors.

UCLA Case No. 2011-565
Lead Inventor: George Grüner
Patent Status: *Pending*
Materials| composites| nano| electronics

Material for Mitigating Impact Forces with Collision Durations in Nanoseconds to Milliseconds Range

Professor Gupta and colleagues have developed a material (and method of production thereof) that is extremely effective in mitigating impact forces across a wide range of collision-durations. Because of the wide range of applicability, this material could be used in virtually all areas of recreational and professional sports to reduce impact forces and the probability of concussions and traumatic brain injury to football players and our soldiers by insertion of only a 2 mm thick layer in helmets. Inserts in current running shoes have resulted in reduction in knee forces.

UCLA Case No. 2011-177
Lead Inventor: Vijay Gupta
Patent Status: *Pending*
Materials| polymers

Multifunctional Polymer Nanocomposite Preparation Methodologies

Professor Hahn and colleagues have identified methods for manufacturing multifunctional polymer nanocomposites containing various fillers, including metal and ceramic nanoparticles. The fabrication methods are versatile enough to produce both flexible and robust final products and work with thermoplastic and thermosetting polymer matrix materials. The keys to the method are monomer stabilization and solvent extraction, producing a final process that is efficient and environmentally friendly.

UCLA Case No. 2008-452
Lead Inventor: Hong (Thomas) Hahn
Patent Status: *Issued* – #8,372,908
Materials| manufacturing| polymers

GaAs/InGaAs Axial Heterostructure Formation in Nanopillars by Catalyst-Free Selective Area MOCVD

Professor Huffaker and colleagues have developed a novel catalyst-free growth technique that allows formation of multiple axial GaAs/InGaAs hetero-structures with controllable indium composition and thickness. This method allows the user to control the formation of axial nanopillar hetero-structures which is crucial for optimized device integration.

UCLA Case No. 2011-522
Lead Inventor: Diana Huffaker
Patent Status: *Pending*
Materials| composites| manufacturing| nano

Pothole Repair for Asphalt and Concrete Base Aggregates

Professor Ju and colleagues have developed a strong bonding polymer that offers a long-term solution to asphalt and cement pothole repair patching material. Because the new polymer has high fracture toughness and impact absorbing ability, it serves as a continuous structural cage material for holding aggregates together even when heavy traffic stresses are applied. Furthermore, due to its adjustable viscosity, the material provides penetration depth control for various applications.

UCLA Case No. 2009-731
Lead Inventor: Jiann-Wen (Woody) Ju
Patent Status: *Pending*
Materials| construction| concrete| asphalt

Rapid Bulk Synthesis of Carbon Nanotubes

Professor Kaner and colleagues have developed a rapid method for the bulk synthesis of carbon nanotubes and graphite encapsulated metal nanoparticles. The method is highly efficient, inexpensive, and readily scalable to multi- and single-walled nanotubes.

UCLA Case No. 1999-245
Lead Inventor: Richard Kaner
Patent Status: *Issued* – #6,479,028
Materials| polymers| nano

Efficient Synthesis of Carbon Nanotubes at Low Temperature

Professor Kaner and colleagues have developed a novel process for the low-temperature formation of nanorods and nanoscrolls of various inorganic layered materials or compounds. In particular, this method can be used to form carbon nanoscrolls, a structure analogous to multi-walled carbon nanotubes. These materials may be used for hydrogen storage, electronic devices, supercapacitors, battery electrodes, or high-strength structural composites.

UCLA Case No. 2002-079
Lead Inventor: Richard Kaner
Patent Status: *Issued* – #6,872,330
Materials| composites| nano

Nanoelectronic Devices Based on Nanowire Networks

Professor Kaner and colleagues have developed networks of molecular nanowires that can be used to control electrical properties. Using networks of nanowires makes them more robust and immune to defects. Moreover, these nanowires can be cheaply manufactured using a variety of techniques. They have applications in biological and chemical sensing.

UCLA Case No. 2004-043
Lead Inventor: Richard Kaner
Patent Status: *Pending* – Published Application #20060284218
Materials| manufacturing| nano| electronics

Polyaniline Nanofibers as Hydrogen Sensors

Professor Kaner and colleagues have developed a method for sensing hydrogen using polyaniline nanofiber material. The approach utilizes detectable conductivity changes in the nanofiber material when exposed to hydrogen gas. This polyaniline sensor has advantages over traditional palladium-based sensors in that its phase change for detection is reversible and its synthesis is inexpensive.

UCLA Case No. 2007-391
Lead Inventor: Richard Kaner
Patent Status: *Pending* – Published Application #20110300637
Materials| nano

Rhenium Diboride, an Ultra-Incompressible, Superhard Material

Professor Kaner and colleagues have developed a method to manufacture a superhard material, rhenium diboride (ReB_2), at ambient pressures. They have shown this material possesses incompressibility along its c-axis similar to that of diamond, has a high differential stress, and has high hardness under low load similar to cubic boron nitride.

UCLA Case No. 2008-619
Lead Inventor: Richard Kaner
Patent Status: *Issued* – #8,431,102
Materials| composites

Polyaniline Nanofiber Composite Materials: New Chemical Sensors for Phosgene

Professor Kaner and colleagues have developed a sensor with polyaniline polymers for the detection of phosgene ($COCl_2$), a colorless, highly toxic gas that has been used in chemical warfare as well as in industrial processes for polyurethanes. The approach provides a sensitive (ppb) method to detecting this highly poisonous gas.

UCLA Case No. 2008-717
Lead Inventor: Richard Kaner
Patent Status: *Pending* – Published Application #20100006334
Materials| nano

Nanostructured Polymer Electrodes

Professor Kaner and colleagues at UCLA and Caltech have developed novel electrode structures for use in the storage of ions made with novel nanostructured polymer films. This technology takes advantage of a new class of nanofiber conjugate polymer materials to form amphoteric electrodes that demonstrate improved cycling properties and remarkable application flexibility.

UCLA Case No. 2010-480
Lead Inventor: Richard Kaner
Patent Status: *Pending* – Published Application #20110229759
Materials| polymers| nano| electronics

Rapid Solid-State Metathesis Routes to Nanostructured Silicon-Germanium

Professor Kaner and colleagues at UCLA and JPL have developed a method for producing unfunctionalized nanostructured silicon and silicon-germanium through a solid state metathesis reaction that is very efficient and inexpensive. The method does not require any expensive equipment and instead relies on favorable thermodynamics to drive the formation of the nanostructured materials. Overcoming the previous limitations of the manufacturing methods could lead to cost-effective utilization of these materials, with applications focusing on energy storage and energy conversion.

UCLA Case No. 2010-656
Lead Inventor: Richard Kaner
Patent Status: *Pending* – Published Application #20110318250
Materials| polymers| nano

Patterning, Electronic Tuning and Electrochemical Activity of Laser Converted Graphene

Professor Kaner and colleagues have developed a novel facile, "green method" for generating, patterning, and electronically tuning graphene-based materials at low cost. The electrical properties of this laser-converted graphene can be tuned over five orders of magnitude, a feature proven difficult with other methods. The simultaneous reduction and patterning of graphite oxide offers substantial versatility in the fabrication of electronic devices, organic devices, asymmetric films, microfluidic devices, integrated dielectric layers, batteries, gas sensors, and electronic circuitry.

UCLA Case No. 2011-127
Lead Inventor: Richard Kaner
Patent Status: *Pending*
Materials| manufacturing| composites| electronics

Compositional Variations of Tungsten Tetraboride with Transition Metals and Light Elements

Professor Kaner and colleagues have developed a method of improving the hardness of tungsten tetraboride (WB_4), by substituting various concentrations of tungsten and/or boride with transition metals and light elements, respectively. In addition to being inexpensive and possessing metallic conductivity, initial samples of the developed materials exhibit Vickers hardness to well above 50 GPa, >15% far higher than the hardness of WB_4.

UCLA Case No. 2011-657
Lead Inventor: Richard Kaner
Patent Status: *Pending*
Materials| composites

Mechanochemical Synthesis of Mg_2Si and Related Compounds and Alloys

Professor Kaner and colleagues have developed methods to synthesize substantially phase pure compounds of magnesium silicide and related alloys. The phase purity achieved by this method is unprecedented, and the yielded products are suitable to be used as thermoelectric materials in the mid- to high-temperature range (400 K to 800 K).

UCLA Case No. 2011-721
Lead Inventor: Richard Kaner
Patent Status: *Pending* – Published Application #20120138843
Materials| manufacturing| composites| electronics

Laser Printing of Flexible Graphene-Based Supercapacitors with Ultrahigh Power and Energy Densities

Professor Kaner and colleagues have developed a method to create flexible and all-organic supercapacitors using inexpensive lasers. Unlike commercial supercapacitors, these show ultrahigh energy density values approaching those of batteries, while maintaining high power density and excellent cycle stability. In addition, the surprising flexibility of these novel supercapacitors makes them ideal for new portable electronics.

UCLA Case No. 2012-291
Lead Inventor: Richard Kaner
Patent Status: *Pending*
Materials| manufacturing| electronics

Fabrication Method of SOI with Partially Different Thicknesses

Professor Koonath and colleagues have developed and reduced to practice a method to fabricate silicon on insulator (SOI) substrates that have partially different thicknesses within a layer. Using a simple fabrication process, conventional lithography and etching steps allow for control over the formation of the insulating layer of a SOI substrate. This novel and simple process gives the user a high degree of control over the thickness of the SOI layers as well as three-dimensional patterning of the insulating layer of the SOI substrate. This technology can be used to produce mixed loading circuits, where devices that require opposing design parameters can be integrated onto a single chip.

UCLA Case No. 2004-328
Lead Inventor: Prakash Koonath
Patent Status: *Issued* – #7,368,359
Materials| manufacturing| electronics

Molecular Nanowires from Single-Walled Carbon Nanotubes

Professor Kwang and colleagues have successfully produced significant amounts of nanowires within single-walled carbon nanotubes. The single-walled carbon nanotubes were synthesized by various methods and filled with materials from the gas, solution, or solid phases. Length-to-diameter ratios on the order of hundreds have been achieved. These nanowires could be further developed to impart novel electrical, superconducting, optical, or magnetic properties.

UCLA Case No. 1999-258
Lead Inventor: Ching Hwa Kwang
Patent Status: *Issued* – #7,112,315
Materials| polymers| nano| electronics

A Method for Preparing Organically Soluble Monodisperse, Metal Particles of Catalytically Active and Non-Catalytically Active Materials

Professor Leff and colleagues have developed a method of preparing monodispersely sized particles of uniform shape with well-defined surface compositions. Organically-functionalized nanometer-scale particles of catalytically-active metals have extremely high surface areas (a large number of catalytically active sites per particle) and unique size-dependent chemical behavior, enabling their application in a variety of homogenous and heterogeneous catalytic processes, from petroleum cracking to polymer synthesis.

UCLA Case No. 1995-560
Lead Inventor: Daniel Leff
Patent Status: *Issued* – #6,103,868
Materials| polymers| nano

Aqueous Electrodeposition of Magnetic Co-Sm Alloys

Professor Nobe and colleagues have developed a continuous, low capital and operating cost process that produces Co-Sm alloys from aqueous plating solutions by electrodeposition. Manufacturing costs of the electrodeposition method can be as little as one-tenth that of other known physical methods. Furthermore, this process enables electroforming (an electrodeposition procedure) of magnetic materials on complex geometries, which cannot be achieved by other processes currently in use.

UCLA Case No. 2007-140
Lead Inventor: Ken Nobe
Patent Status: *Pending* – Published Application #20120049102
Materials| manufacturing| electronics

New Materials for the Formation of Polymer Junction Diodes

Professor Pei and colleagues have developed innovative polymer p-i-n junction diodes formed by simple solution processing at ambient conditions. The diodes are particularly useful for applications requiring electroluminescence with high quantum or power efficiency, photodetection at high sensitivity, solar energy conversion at high efficiency, and large area thin film transistors capable of carrying high current densities.

UCLA Case No. 2005-239
Lead Inventor: Qibing Pei
Patent Status: *Issued* – #7,939,900
Materials| polymers, Energy| solar

Copolymers of Alkyioxythiophene

Professor Pei and colleagues have developed low bandgap conjugated copolymers based on Alkyloxythiophene monomers. These copolymers exhibit superior electrical characteristics appropriate for polymeric solar cells, LEDs, and thin-film transistors.

UCLA Case No. 2006-494
Lead Inventor: Qibing Pei
Patent Status: *Pending* – Published Application #20090095343
Materials| polymers

Bistable Electroactive Polymers

Professor Pei and colleagues have developed a bistable electroactive polymer transducer for electrically actuated deformation of rigid electroactive polymer members. They can be electrically deformed to various rigid shapes with maximum strain greater than 100% and as high as 400%. The polymer transducers' advantages include high energy and power densities, quietness, mechanical compliancy (for shock resistance and impedance matching), high efficiency, lightweight, and low cost.

UCLA Case No. 2009-356
Lead Inventor: Qibing Pei
Patent Status: *Issued* – #8,237,324
Materials| polymers

Bulk Polymer Composites

Professor Pei and colleagues have developed a method of synthesizing novel composite polymers suitable for detection of radiation, including beta rays, positrons, gamma rays, X-rays, and neutron particles. The all-organic matrix exhibits as much as 45,000/MeV light yield — more than 2 times that of the current champion organic scintillators, and a gamma (662 keV) photoelectric peak with 10% resolution in the composite scintillator. Moreover, the synthetic chemistry for their production utilizes inexpensive materials.

UCLA Case No. 2012-334
Lead Inventor: Qibing Pei
Patent Status: *Pending*
Materials| polymers

High Efficiency Organic Light Emitting Diodes

Professor Pei and colleagues have developed a novel approach to fabricating organic light emitting diodes (OLEDs) using transparent composite electrodes, that greatly increases their emission efficiency. The composite electrodes are thin, flexible, compatible with solution-based processing, and improve the light outcoupling efficiency. The new OLEDs are highly flexible and are at least twice as efficient as comparable OLEDs fabricated on ITO/glass. These new techniques can be used to more economically produce higher-efficiency OLEDs, which are becoming increasingly prevalent in medical devices, smartphones, and other portable or wearable electronics.

UCLA Case No. 2013-001
Lead Inventor: Qibing Pei
Patent Status: *Pending*
Materials| manufacturing

Phase Change Materials in Concrete: Method for Enhancing the Thermal Damage Resistance of Structures

Professor Sant and colleagues have developed a method to enhance both the thermal damage resistance and energy efficiency of concrete structures by embedding phase change materials (PCM). By storing and releasing energy, PCMs limit thermal fluctuations, thereby reducing stress development and subsequent cracking. Moreover, minimizing thermal volatility can help promote energy conservation in building operations.

UCLA Case No. 2012-289
Lead Inventor: Gaurav Sant
Patent Status: *Pending*
Materials| concrete

Photoactivity and Ion-Exchange as New Routes to Corrosion Inhibition in Reinforced Concrete

Professor Sant and colleagues have developed a strategy to limit steel corrosion processes in concrete structures. This approach combines topical and integral methods of anatase deployment expected to be superior to current methods of steel corrosion inhibition, being both regenerative and tunable. By using an unprecedented combination of real and virtual experiments, this method represents a significant advance in the design and development of new infrastructure material systems.

UCLA Case No. 2012-702
Lead Inventor: Gaurav Sant
Patent Status: *Pending*
Materials| concrete

Methods to Control and Predict Cement Reaction Rates Using Tailored Limestone Powder Additions

Professor Sant and colleagues have developed an easy-to-use tool to predict and control the reaction rate of cement using tailored limestone replacements. By simply inputting desired material property parameters, the tool will perform calculations to provide appropriate mixture proportions needed to achieve said parameters. The tool can also recommend alternative mixtures of cement and limestone to yield the same material properties. By using this invention, concrete technologists can quickly assess process parameters needed to prepare a mixture that fits their desired material properties, without performing expensive and time-consuming experiments.

UCLA Case No. 2012-784
Lead Inventor: Gaurav Sant
Patent Status: *Pending*
Materials| concrete

Inorganic Admixtures for Preventing Conversion Phenomena in High-Alumina Cements

Professor Sant and colleagues have developed a method to prevent the strength loss caused by increased porosity seen in high alumina cement systems. The addition of inorganic admixtures serves to suppress hydrogarnet formation at the expense of more stable AFm phases. The result is high-alumina cement with increased volume stability and corrosion resistance.

UCLA Case No. 2013-634
Lead Inventor: Gaurav Sant
Patent Status: *Pending*
Materials| concrete

Solution-Processible Inorganic Ordered Vertically-Oriented Porous Films

Professor Tolbert and colleagues have created a technique for producing vertically oriented inorganic pore systems via solution processing. Using this novel procedure, a hexagonal honeycomb structured surfactant or polymer templated inorganic-organic composite is grown on a cubic self-assembled patterned surface to form the vertically aligned pores. Unlike many traditional methods, this innovative procedure can utilize a variety of materials to form the film structure, which enhances substrate versatility. Additionally, the use of a cubic self-assembled liquid crystal system for a substrate to align a hexagonal self-assembled liquid crystal system allows the realization of superior feature size and material control.

UCLA Case No. 2005-728
Lead Inventor: Sarah Tolbert
Patent Status: *Issued* – #8,399,057
Materials| polymers, Water| membranes

Magnetoelectric Control of Superparamagnetism

Professor Tolbert and colleagues have developed a system with the ability to intrinsically control overall net magnetization through the application of electric fields. Strain transfer from the substrate to the magnetic component of the system results in perturbation of the magnetization of the system. The commercial applications for this invention include but are not limited to memory, controlling magnetism, motors and logic devices.

UCLA Case No. 2013-470
Lead Inventor: Sarah Tolbert
Patent Status: *Pending*
Materials| manufacturing| electronics

Flip Chip Nanotechnology Using Composite Solder/Sic Nanowire Joints

Professor Tu and colleagues have developed a method to strengthen Pb-free solder joints by adding small quantities of contoured-surface nanowires to the IMC matrix. The composites provide very strong impact fracture toughness, which prevents shearing along the interface. Furthermore, since only small quantities of nanowires are required, the proposed technique provides an affordable solution that meets the new safety regulations.

UCLA Case No. 2009-586
Lead Inventor: King-Ning Tu
Patent Status: *Pending*
Materials| manufacturing| electronics

Thermally Re-mendable Cross-Linked Polymers

Professor Wudl and colleagues have developed a method of making thermally re-mendable polymers. These transparent and colorless polymeric solids can be fabricated without the use of solvent and cured at temperatures ranging from 80° C to 120° C. Once a crack is propagated in this cured material, the crack can readily be thermally repaired. Upon heating the polymeric body to 120° C, many bonds within the material break. Upon slow cooling back to room temperature, these bonds reform in a way that allows for the repair of the fracture. This procedure can successfully be repeated multiple times on the same sample.

UCLA Case No. 2002-343
Lead Inventor: Fred Wudl
Patent Status: *Issued* – #6,933,361
Materials| manufacturing, polymers

Spin Injector

Professor Xie and colleagues have developed a fundamentally new approach for efficient spin injection that can inject charge carriers such that near 100% of the charge carriers are spin polarized. The approach avoids the drawbacks and shortcomings associated with diffusion-based current injection and tunnel injection. The spin injector can enable viable spin FETs composed of ferromagnetic material sandwiched between two semiconductors, which may potentially provide an alternative to Si CMOS electronics. This technology has broad applications across electronics development, including computer memory, data storage devices, spin FETs, and spintronics.

UCLA Case Nos. 2006-689, 2006-725
Lead Inventor: Ya-Hong Xie
Patent Status: *Issued* – #8,233,315, #8,101,984
Materials| manufacturing| electronics

CeramicAsh: Material and Method

Professor Yang and colleagues have developed a method to utilize the waste product fly ash to make CeramicAsh, a chemically bonded ceramic. Fabricated at room temperature, CeramicAsh exhibits high compression strength, fire resistance, and extremely low density. The inventors have demonstrated that the material's density, transparency, and pH can be tailored to produce specific solutions. Such versatility allows for myriad potential applications for this inexpensive yet robust new material.

UCLA Case No. 2012-114
Lead Inventor: Jenn-Ming Yang
Patent Status: *Pending*
Materials| composites

New Lead-Boron-based Ceramics

Professor Yang and colleagues have developed a new fast-setting ceramic-cement material, fabricated with lead and boron compounds. In addition to shielding gamma rays and neutrons, these materials also effectively encapsulate radioactive nuclear and hazardous wastes. They also exhibit high temperature resistance and extraordinary compressive strength; one experimental composite recorded a mean value of 50 MPa, far exceeding the 3.45 MPa required for nuclear waste applications.

UCLA Case No. 2012-125
Lead Inventor: Jenn-Ming Yang
Patent Status: *Pending*
Materials| composites

Organic Bistable Device and Organic Memory Cells

Professor Yang and colleagues have developed a bistable electrical device employing a bistable body and a high conductivity material. A sufficient amount of high conductivity material is included in the bistable body to impart bistable between a low resistance state and a high resistance state by application of an electrical voltage. These devices are well suited for use as electrical switching and memory devices.

UCLA Case No. 2001-129
Lead Inventor: Yang Yang
Patent Status: *Issued* – #6,950,331
Materials| manufacturing| electronics

Organic Electrical Bistable Devices Fabricated by Solution Processing

Professor Yang and colleagues have developed a new series of composite materials that can be used as non-volatile electronic memory devices that exhibit bistable behavior. In general, the materials are composed of a dielectric matrix material containing an organic polymer and/or an inorganic oxide, which collectively acts as an electron donor and an electron acceptor. Electronic memory and switching devices manufactured from these films can be produced more easily and inexpensively with reduced power and thermal requirements, enabling stacking in various configurations to fabricate electronic devices of higher density.

UCLA Case No. 2003-194
Lead Inventor: Yang Yang
Patent Status: *Issued* – # 7,274,035
Materials| composites| manufacturing

Rewritable Nano-Surface Organic Electrical Bistable Devices

Professor Yang and colleagues have developed a bistable electrical device that is convertible between a low and high resistance state. The device includes at least one layer of organic low conductivity material sandwiched between two electrodes. A buffer layer is located between the organic layer and at least one of the electrodes. The buffer layer controls metal migration into the organic layer when voltage pulses are applied between the electrodes to convert the device back and forth between the low and high resistance states.

UCLA Case No. 2003-262
Lead Inventor: Yang Yang
Patent Status: *Issued* – #7,482,621
Materials| manufacturing

High-Throughput Solution Processing of Large Scale Graphene for Device Applications

Professor Yang and colleagues have developed a novel solution process for the large-scale production of single layered graphene. The resulting graphene sheets have the largest area yet reported by an order of magnitude, resulting in significantly easier processing. Field effect devices were also fabricated by conventional photolithography that displayed currents 3 orders of magnitude higher than any ever observed for chemically produced graphene. This versatile technique reproducibly produces large graphene sheets, enabling a vast array of applications.

UCLA Case No. 2008-422
Lead Inventor: Yang Yang
Patent Status: *Pending* – Published Application #20100273060
Materials| manufacturing| polymers

A Simple Route for Grain Growth in Solution-Processed Crystalline Semiconductors

Professor Yang and colleagues have identified a simple route to enlarging the grain size of crystalline semiconductors through the use of alkali metals. They have demonstrated a 5X enlargement of the grain size in a solution-processed metal hybrid semiconductor material. This method has applications in large-scale production of solution-processed semiconductors, transistors, memory devices, LEDs, and solar cells.

UCLA Case No. 2008-552
Lead Inventor: Yang Yang
Patent Status: *Pending* – Published
Application #20120280362
Materials| manufacturing

Solution-Deposition of Cigs Solar Cell by Spray-Coating

Professor Yang and colleagues have developed a solution-based thin-film deposition technique that circumvents the need for vacuum based deposition. Instead, the method utilizes spray coating to form a thin, high-quality inorganic film. This fully scalable technique conforms to control requisites, such as the thickness and the metal ratio in the resulting film, and avoids issues associated with film cracking. The proposed technique is industrially scalable, is high-throughput, and is much less costly than many alternatives.

UCLA Case No. 2009-726
Lead Inventor: Yang Yang
Patent Status: *Pending* – Published
Application #20120073622
Materials| manufacturing

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