

STEPHEN J. HARRIS

Materials Science Division, Lawrence Berkeley Lab
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<http://www.LithiumBatteryResearch.com>

SUMMARY

Creative research scientist with extensive experience in applying chemical and physical insights. Develops pioneering strategies for solving engineering problems, including approaches to improve the durability and increase the energy density of automotive Li ion batteries. Core strengths include building and supporting research alliances, asking tough technical questions, and mentoring young scientists. Judge for DOE's Annual Merit Review, 2012, 2013, and 2016. Key Accomplishments include:

- Research contracts from Army, Navy, DOE, NSF
- Published more than 100 peer-reviewed research papers, >8,300 citations, *h-index* = 49
- Represented General Motors on the US Advanced Battery Consortium and on USDRIVE, setting goals and developing major new initiatives for the DOE
- [Miller Visiting Professor](#) at UC Berkeley, 2012
- Consultant for [LG Chem](#), world's largest automotive battery company, 2015-
- Consultant for Bessemer Venture Partners, 2016-

EDUCATION

[Miller Institute Post-Doctoral Fellowship](#) in Chemistry, **University of California**, Berkeley, CA

Advisor: C. Bradley Moore

Research Topic: Laser-induced chemistry in the ICl₁ + H₂ system

Ph.D. in Physical Chemistry, **Harvard University**, Cambridge, MA

Advisor: William Klemperer

Thesis Topic: Microwave spectroscopy of van der Waals molecules

B.A. in Physical Chemistry, **U.C.L.A.**, Los Angeles, CA

Advisor: Howard Reiss

Research Topic: Theory of the structure of liquids

PROFESSIONAL EXPERIENCE

LAWRENCE BERKELEY LAB, BERKELEY, CA

2013-

Project Scientist, Materials Science Division

- *In situ* measurement of Li⁺ spatial and temporal maps
- X-ray tomography of Li battery electrodes
- IR and Raman studies of the electric double layer

UNIVERSITY OF TEXAS, AUSTIN

2014-5

Senior Research Fellow

CHEMISTRY DEPARTMENT, UC Berkeley, CA

2012

Miller Visiting Professor

- Invented a new battery separator made from porous aluminum oxide that will enable faster safe charging by preventing Li dendrites from short-circuiting the battery
- Developed a research program to improve energy density in Li batteries

GENERAL MOTORS R&D CENTER, Warren, MI 48301

2007-2012

Technical Fellow

Scientific leader of a group of 10 evaluating new Li battery products and technologies

- Explained battery failure with a new theory based on electrode inhomogeneity—that batteries fail because of the presence of weak spots—demonstrating simple techniques to give more durable batteries
- Demonstrated that failed Li-ion batteries can be rejuvenated by dissolving away degradation films, reducing the lifetime cost of batteries
- Secured contract for almost \$1 million, 2009-11 with DOD

FORD RESEARCH AND ADVANCED ENGINEERING CENTER, Dearborn, MI 48121

1998-2007

Technical Leader

Led a group of 6 in tribology developing high throughput methods for making lean NO_x catalysts; led a group of 3 improving coatings for continuously variable transmission disks

- Provided the engineering data for a predictive model of fracture of cast aluminum, allowing engine blocks to be designed with thinner walls (less of a safety margin) for lower weight
- Discovered a universal law to predict the performance of hard coatings, leading development of specific coatings that provide longer lifetimes for gears and bearings
- Discovered a method to operate solid oxide fuel cells at lower temperature by adding dimethyl ether to the fuel, improving their energy efficiency and their durability
- Interpreted measured soot size distributions from diesel engines so that the number of potentially hazardous nano-sized soot particles emitted from any future diesel engine could be predicted
- Received computer program funding through the National Science Foundation based on measurements of stresses in eutectic silicon particles. Program could predict the conditions under which cast aluminum parts (e.g., engine blocks) would crack

GENERAL MOTORS RESEARCH LAB, Warren, MI 48090

1977-1998

Principle Research Scientist

Led a group of 6 studying combustion reactions that produce to regulated emissions in engines

- Discovered a gasoline additive the extends the lean operating range of a gasoline engine, reducing emissions of nitrogen oxides and reducing the cost of catalytic converters
- Discovered the mechanism by which small soot particles grow to large ones—by a series of additions of acetylene molecules, enabling improved predictions of soot mass as a function of diesel engine operating conditions
- Developed an optical sensor for hydrocarbon emissions from vehicles, allowing on-the-road detection of vehicles that do not meet emissions standards
- Created the first model that predicts the formation rate of diamond coatings from chemical vapor deposition, allowing optimum process parameters for making diamond-coated tools to be predicted

OTHER ACCOMPLISHMENTS

- Owner of <http://www.LithiumBatteryResearch.com>, more than 30,000 page views
- Chair of the Energy sub-division, ACS PHYS division
- Chair of the first Gordon Research Conference on Batteries
- Chair of the second Gordon Conference on Diamond Synthesis
- Co-chair of the first Gordon Research Conference on Diamond Synthesis
- External advisory board University of Maryland EFRC (NEES)
- External advisory board University of Texas EFRC
- Executive Committee of the Battery Division, Electrochemical Society
- Funding:
 - First GM scientist to obtain an individual government research contract: (ONR, Chemical Vapor Deposition), \$300,000
 - 2 University Research Program (URP) grants from Ford: Fatigue Modeling, \$270,000
 - NSF Goali award: Ductility of Cast Aluminum, \$420,000
 - NSF Goali award: Fracture in Graphite Fiber Reinforced Composites, \$240,000
 - Award from Automotive Composites Consortium of US CAR: for Random Fiber Composites, \$120,000
 - Award from US Army, Lithium-ion battery degradation mechanisms, \$1.0 million
 - Award from EERE/DOE, Development of a Battery Separator for fast recharge, \$100,000
 - LDRD from LBNL, 2013, \$84,000

RESEARCH TOPICS

- Laser diagnostics of combustion. Laser chemistry.
- Soot formation and the chemistry of rich combustion systems. Modeling and experiment.
- Aerosol dynamics. Modeling
- Chemical vapor deposition of diamond and boron-containing films. Modeling and experiment.
- Tribology and Surface Engineering, Development of tribological coatings. Contact mechanics modeling and prediction of fatigue lifetimes.
- Solid oxide fuel cell chemistry
- Microscopic basis for ductility and fracture in cast aluminum
- Li-ion battery transport and degradation; electric double layers

HONORS

Lawrence Berkeley National Lab

Kavli (Plenary) lecture, Am Physical Society, 2013, https://www.youtube.com/watch?v=7OulrNu_yIk

University of California, Berkeley

Visiting Professor of the Miller Institute for Basic Research in Science, 2012

General Motors

Campbell Award for outstanding research, 1996

Campbell Award for outstanding research, 1985

University of California, Berkeley

Visiting Miller Professor

Fellow of the Miller Institute for Basic Research in Science

University of California Regents Scholar

Harvard

Harvard University Scholarship

Outstanding teaching awards

PATENTS

1. Method for lean operation of spark-ignited engine, US Patent 4,406,254
2. Sensor for measuring alcohol content of alcohol gasoline fuel mixtures, US Patent 5,239,860
3. Sensor for measuring alcohol content of alcohol-fuel mixtures, US Patent 5,262,645
4. Sensor for measuring alcohol content of fuel, US Patent 5,289,860
5. Etching technique for producing cubic boron nitride films, US Patent 5,535,905
6. Corrosion resistant PEM fuel cell, US Patent 5,624,769
7. Modulation schemes for on-board diagnostic exhaust system, US Patent 5,709,082
8. Gear tooth smoothing and shaping process, US Patent 6,170,156
9. Coated fuel injector valve, US Patent 6,508,416
10. Direct operation of low temperature solid oxide fuel cells using oxygenated fuel, WO Patent 2,005,053,077
11. Rejuvenation and reuse of degraded lithium ion battery cells, US Patent 8,535,818
12. Apparatus and method for controlling kinetic rates for internal reforming of fuel in solid oxide fuel cells, US Patent 7,638,226
13. Lithium ion battery, US Patent 9,130,231
14. Liquid-metal negative electrode for lithium-ion batteries, US Patent 8,642,201
15. Self healing lithium-ion battery negative electrodes, product including same, and methods of making and using same, US Patent 8,658,295.
16. Lithium ion secondary battery electrode and method of forming same, US Patent 8,835,056
17. Battery module for mitigating gas accumulation and methods thereof, US Patent 9,281,548

INVITED TALKS (since 1989)

- University of Kentucky, October, 2016
- CINT, Sandia National Lab, September, 2016
- Florida State University, March, 2016
- Texas A&M University, March, 2016
- American Chemical Society, March, 2016
- Stanford University, August, 2015
- Xerox PARC, September, 2015
- Materials Research Society, November, 2014
- American Chemical Society, September, 2014
- Telluride Science Research Center, July, 2014
- Keynote speaker at Science and Technology Facilities Council, June, 2014
- Gordon Research Conference on Batteries, March, 2014
- American Vacuum Society, October, 2013
- American Chemical Society, September, 2013
- Wesleyan University, May, 2013
- Penn State Math Department, March, 2013
- Kavli (Plenary) talk, APS, March, 2013
- Caltech, February, 2013
- NIST, January, 2013
- University of Texas, Austin, November, 2012
- Army Research Lab, October, 2012
- Purdue University, October, 2012
- Dept of Energy (ARPA-E, EERE, and BES), October, 2012
- Princeton University, April, 2012
- Materials Research Society, April, 2012
- UC Berkeley, Chemistry Dept., February, 2012
- Sandia National Lab, January, 2012
- International Symposium on Clusters and Nanostructures, November, 2011
- Northwestern University, Materials Science and Engineering, November, 2011
- University of Pittsburgh, Department of Physics and Astronomy, November, 2011
- University of Michigan, Mechanical Engineering Dept., June, 2011
- Brown University, Mechanical Engineering Dept., February, 2011
- Materials Research Society, December, 2010
- National Renewable Energy Lab, November, 2010
- Electrochemical Society, October, 2010
- MIT, Chemical Engineering Dept., May, 2010
- NIST, Gaithersburg, MD, March 2010
- Sandia National Labs, Livermore, January, 2010
- UC Berkeley, Chemistry Department, January, 2010
- UC San Diego, Nanoengineering Dept., January, 2010
- Caltech MRL, June, 2009
- Lawrence Livermore Lab, March, 2009
- UC Berkeley, Mechanical Engineering Dept., March, 2009
- Ohio State University, Mechanical Engineering Dept., January, 2009
- University of Michigan, Materials Science Dept., February, 2008
- N.I.S.T., Gaithersburg, MD, December, 2005
- Naval Research Labs, December, 2005
- Naval Postgraduate School, November, 2004

- Rutgers University, Mechanical Engineering Dept., February, 2004
- NUMIFORM conference, 2004
- Northwestern University, Mechanical Engineering Dept., August 2002
- Gordon Conference on Tribology, August 2002
- International Conference on Metallurgical Coatings and Thin Films, May 2001
- University of Wisconsin–Madison, Engineering Physics Dept., April, 2001
- Georgia Institute of Technology, Mechanical Engineering Dept., March 2000
- Euromat 1999, Munich, Germany, September 1999
- International Conference on Metallurgical Coatings and Thin Films, April 1999
- Wesleyan University, Chemistry Dept., February 1999
- Northwestern University, Civil Engineering Dept., October 1998
- Argonne National Labs, March, 1998
- University of Chicago, Chemistry Dept., February 1998
- Caltech, Chemistry Dept., December 1997
- University of Illinois, Chicago, Chemical Engineering Dept., November, 1997
- Electrochemical Society, CVD Session, May, 1996
- Materials Research Society, Diamond Session, November, 1995
- International Conference on Metallurgical Coatings and Thin Films, April, 1995
- Wayne State University, Chemistry Dept., March, 1995
- MIT, Chemistry Dept., November, 1994
- Chairman, Gordon Research Conference on Diamond Synthesis, June, 1994
- Stanford University, April, Mechanical Engineering Dept., 1994
- University of Michigan, Chemistry Dept., March, 1994
- University of Southern California, Applied Math Dept., December, 1993
- Yale University, Chemical Engineering Dept., November, 1993
- Penn State University, Chemistry Dept., October, 1993
- Caltech, Chemical Engineering Dept., April, 1993
- SRI International, Workshop on Fundamental Aspects of Diamond CVD, November, 1992
- Gordon Research Conference on Plasma Chemistry, August, 1992
- Co-Chairman, Gordon Research Conference on Diamond Chemical Vapor Deposition, June, 1992
- Harvard University, Chemistry Dept., May, 1992
- Cornell University, Chemistry Dept., March, 1992
- American Chemical Society, September, 1991
- University of Mass., Amherst, Chemical Engineering Dept., May, 1991
- Industrial Liaison Program, "Chemistry at Interfaces," MIT, May, 1991
- Electrochemical Society, May, 1991
- American Physical Society, March, 1991
- Caltech, Chemistry Dept., January, 1991
- University of California, Berkeley, Chemistry Dept., January, 1991
- University of Wisconsin, Madison, Chemistry Dept., October, 1990
- International Conference on New Diamond Science and Technology Sept., 1990
- Co-Director, American Carbon Conference, May, 1990
- University of Illinois, Chicago, Chemical Engineering Dept., April, 1990
- Case Western, Chemical Engineering Dept., February, 1990
- Princeton, Mechanical Engineering Dept., December, 1989
- MIT, Chemical Engineering Dept., November, 1989
- University of Illinois, Urbana, Chemistry Dept., October, 1989