



## 2014 DORN MEMORIAL LECTURE

### Harry A. Atwater

Professor of Applied Physics and Materials Science  
California Institute of Technology

**Tuesday, January 21, 2014**

**Tech L211, 4:00pm**

*Reception to follow*

*Cook Hall - Atrium, 5:15pm*

### “Tunable and Quantum Plasmonic Materials”

Understanding the fundamental properties of plasmonic and dielectric materials in resonant subwavelength structures has fueled an explosion of interest in metamaterials and nanophotonic devices. In this seminar, we explore new directions for plasmonics by examining the relationship between plasmons and the electrochemical potential of the electron gas, and we discuss opportunities to observe quantum coherent states in plasmonic structures. Usually plasmons are described in a classical electromagnetic theory context, yet plasmons are fundamentally quantum excitations. Moreover, the carrier density and optical properties of plasmonic materials are typically fixed at the time of fabrication. Field effect tuning of the electrochemical potential in graphene nanoresonators enables the plasmon and phonon dispersion to be measured. Electrochemical and carrier density modulation in metals yields tunable resonances in metal nanostructures and reveals the plasmoelectric effect, a newly-discovered photoelectrochemical potential. By tuning the permittivity and index to near-zero values, expands the length scale over which coherent quantum emitter phenomena (e.g., concurrence, superradiance) can be observed in epsilon-near-zero media. Finally, we demonstrate entanglement or coherent superposition states of single plasmons using two plasmon-quantum interference in chip-based plasmon waveguide directional couplers.

**Biography:** Harry Atwater is the Howard Hughes Professor of Applied Physics and Materials Science at the California Institute of Technology. Professor Atwater currently serves as Director of the DOE Energy Frontier Research Center on Light-Matter Interactions in Solar Energy Conversion, and is also Director of the Resnick Institute for Science, Energy and Sustainability, Caltech’s largest endowed research program. Atwater’s scientific interests have two themes: plasmonics and optical metamaterials as well as photovoltaics and solar energy. His group has developed principles for light management in photovoltaics and have created new high efficiency solar cell designs. He is co-founder and chief technical advisor for Alta Devices, a venture-backed company in Santa Clara, CA, which has developed a low cost GaAs photovoltaics technology with world record cell efficiency. Atwater is an early pioneer in nanophotonics and plasmonics; he gave the name to the field of plasmonics in 2001. He has authored or co-authored more than 400 publications and his group’s advances in the solar energy and nanophotonics field have been reported in Science, Nature Materials, Nature Photonics, PNAS, Advanced Materials and Scientific American,.

# Materials Science and Engineering

Harry Atwater is the founding Editor in Chief for *ACS Photonics* (2013), and in 2006 he founded the Gordon Research Conference on Plasmonics, which he served as chair in 2008. Atwater is a Fellow of the Materials Research Society, and Member of the Bohmische Physical Society. He has been honored by several awards, including: (2013) Fellowship from the Royal Netherlands Academy of Arts and Sciences, (2012) ENI Prize for Renewable and Non-conventional Energy, SPIE Green Photonics Award (2012), MRS Kavli Lecturer in Nanoscience (2010), the Popular Mechanics Breakthrough Award (2010). He received the Joop Los Fellowship from the Dutch Society for Fundamental Research on Matter (2005), the A.T.&T. Foundation Award (1990). He won the NSF Presidential Young Investigator Award (1989) and the IBM Faculty Development Award in 1989-1990.

Professor Atwater has worked extensively as a consultant for industry and government, and has actively served the materials community, including Material Research Society Meeting Chair in 1997, AVS Electronic Materials and Processing Division Chair in 1999, Materials Research Society President in 2000, and Board of Trustees of the Gordon Research Conferences. He also teaches graduate level Applied Physics classes at Caltech in optoelectronics, solid-state physics and device physics.

Professor Atwater received his B. S., M. S. and Ph.D. degrees from the Massachusetts Institute of Technology respectively in 1981, 1983 and 1987. He held the IBM Postdoctoral Fellowship at Harvard University from 1987-88, and has been a member of the Caltech faculty since 1988.

#### Web Links:

<http://www.lmi.caltech.edu>

<http://resnick.caltech.edu/index.html>

<http://daedalus.caltech.edu>

<http://pubs.acs.org/journal/apchd5>