

## Plasmonics - Photons at the Nanoscale Yield Physics, Metamaterials, and Devices

### GUEST SPEAKER

**Prof. Harry Atwater**  
California Institute of Technology

When: **1<sup>st</sup> July 2009, 3.00 p.m. to 4.00 p.m.**  
Where: **Institute of Microelectronics, Singapore (Level 2, Auditorium)**  
11 Science Park Road Singapore Science Park II Singapore 117685

### **Abstract**

Plasmonics is a rapidly emerging photonics discipline that enables unusual dispersion engineering and mode localisation, and it has an impact on the development of metamaterials and active nanophotonic devices. Dispersion control and active materials integration have yielded plasmonic components, including (i) three-dimensional single layer plasmonic metamaterials, (ii) all-optical, electro-optic and field effect modulation of plasmon propagation and (iii) plasmon-enhanced absorption in solar cells.

We will expand upon recently reported work on direct observation of two-dimensional negative refraction in the visible frequency range to develop a general approach to realisation of three-dimensional single-layer, all-angle, polarisation-independent plasmonic metamaterials exhibiting negative refraction. Full wave simulations and dispersion calculations are used to demonstrate that metal-dielectric-metal plasmonic structures are characterised by negative wave vectors and negative refractive indices. Metal-dielectric plasmon waveguides can serve as active switching elements when the dielectric refractive index can be actively modulated.

We will demonstrate electro-optic refractive index modulation in metal-dielectric-metal plasmon waveguides using low-voltage electro-optic modulation of both silicon and perovskite oxide dielectric layers. The efficiency and cost effectiveness of photovoltaic cells can both be increased by reduction of the active semiconductor absorber layer thickness and ability to fabricate ultrathin absorber layers opens up new possibilities for solar cell device design. The strong mode localisation of surface plasmon polaritons at metal-dielectric interfaces leads to strong absorption in semiconductors thin films, enabling a dramatic reduction in the semiconductor absorber physical thickness needed to achieve an optically thick film. Modal analysis in full wave simulation allows us to determine the fraction of power absorbed by the solar cell for both dielectric and plasmonic modes.

### **Speaker Biography**



Prof. Harry Atwater is currently Howard Hughes Professor and Professor of Applied Physics and Materials Science at the California Institute of Technology. Prof. Atwater received his S.B. (1981), S.M. (1983), and Ph.D. (1987) in Electrical Engineering from the Massachusetts Institute of Technology.

His research interests are plasmonics, nanophotonics, photovoltaics and photoelectrochemical devices for solar fuel production. He is an early pioneer in surface plasmon photonics; he gave the name to the field of plasmonics in 2001. He has authored or co-authored over 200 publications, and his group's developments in the plasmonics field have been featured in *Scientific American* and in research papers in *Science*, *Nature Photonics* and *Advanced Materials*.

Prof. Atwater currently serves as Director of Caltech's Centre for Science and Engineering of Materials (an NSF MRSEC; [www.csem.caltech.edu](http://www.csem.caltech.edu)), and is also Director of the Caltech Centre for Sustainable Energy Research ([www.ccser.caltech.edu](http://www.ccser.caltech.edu)). He is founder and chief technical advisor for Alta Device, a solar energy company, and Aonex Corporation, a compound semiconductor materials company. He is also an editorial board member for *Surface Review and Letters*.

Prof. Atwater has been honoured by awards including the Joop Los Fellowship from the Dutch Society for Fundamental Research on Matter, 2005; A.T. & T. Foundation Award, 1990; NSF Presidential Young Investigator Award, 1989; IBM Faculty Development Award, 1989-1990; Member, Bohmische Physical Society, 1990; IBM Postdoctoral Fellowship, 1987. He has also consulted extensively for industry and government, and has actively served the materials community in various capacities.

### Registration

Pre-registration required. Please send the following details through email to:

Ms. Daphne Khong E-mail: [khongkw@scei.a-star.edu.sg](mailto:khongkw@scei.a-star.edu.sg)

Closing Date: Tuesday, 30<sup>th</sup> June 2009

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