SPIE Optics+Photonics

Hot Papers

Sunday 1 August

Time: 9:00 AM - 9:30 PM
Active plasmonic and metamaterials and devices *(Invited Paper)*
Paper 7754-2
Author(s): Larry R. Dalton, Univ. of Washington (United States)

Organic nonlinear optical materials are incorporated into silicon photonic, plasmonic, and metamaterial device architectures. Active optical control performance, optical loss, and bandwidth are evaluated as function of materials and of device dimensions. Particular attention is paid to optical loss and bandwidth issues as these have significantly inhibited the broad utilization of plasmonic and metamaterial devices.

Time: 9:00 AM - 9:20 AM
Microdisk THz quantum-cascade lasers with super-conducting cavities
Paper 7763-2
Author(s): Alexander Benz, Martin Brandstetter, Christoph Deutsch, Gernot Fasching, Karl Unterrainer, Aaron Maxwell Andrews, Pavel Klang, Werner Schrenk, Gottfried Strasser, Technische Univ. Wien (Austria)

We present the realization of a super-conducting cavity for terahertz (THz) quantum-cascade lasers (QCLs) emitting at 2 THz. The resonator is disk shaped with diameters down to 100 um. In contrast to the conventional double-metal waveguide, we have replaced the Gold layers by Niobium. Thereby, we achieve a super-conducting optical cavity. The current-voltage characteristic shows the typical, pronounced kinks at threshold and at maximum emission.

Time: 9:30 AM - 10:30 AM
Design and fabrication of ultrathin photonic crystal crystalline silicon solar cells
Paper 7771-4
Author(s): Shrestha Basu Mallick, Stanford Univ. (United States); Mukul Agrawal, Applied Materials, Inc. (United States); Artit Wangperawong, Peter Peumans, Stanford Univ. (United States)

Our theoretical simulations show that structuring thin silicon films into 2D slab photonic crystals (PCs) increases the maximum achievable photocurrent density from 7.1mA/cm2 for a solid slab to 21.8mA/cm2 for a 400 nm-thick PC structure, for normal incidence. We discuss the fabrication of these double-layer PC structures using a combination of isotropic and anisotropic etches. We show using device simulations, that despite the large amount of surface area introduced by the PC approach, cell performance is not expected to suffer for well-known surface passivation schemes. The effect of contact layout and placement on the practically achievable device efficiency is discussed.

Time: 9:30 AM - 10:00 AM
Active control of near-IR metamaterials utilizing stretchable elastomeric polymers

and phase-transition materials *(Invited Paper)*
Paper 7754-3
Author(s): Koray Aydin, Imogen M. Pryce, Yousif A. Kelaita, Harry A. Atwater, Jr., California Institute of Technology (United States)

We demonstrate the first mechanically tunable metamaterial in the near infrared, where modifying the distance between coupled resonator elements changes the resonance frequency. We show that the resonant peak wavelength can be shifted by up to 350 nm, a full linewidth shift around 4 µm. Here we extend our first reports on planar hybrid Ag/VO2 SRR bi-layers to the use of laterally patterned VO2 hybrid nanostructures. Amplitude modulation (~%30) and resonance frequency tuning (~110 nm) can be achieved in planar Ag/VO2 hybrid SRRs the 1-4 µm wavelength range, and results for laterally-patterned structures will be discussed.

Time: 10:10 AM - 10:30 AM
Detection of swine-origin influenza A (H1N1) viruses using a paired surface plasma waves biosensor
Paper 7759-5
Author(s): Li-Chen Su, National Central University (Taiwan); Ying-Feng Chang, National Yang-Ming University (Taiwan); Ying-Chang Li, Cheng-Chung Lee, National Central University (Taiwan); Chien Chou, Chang Gung University (Taiwan)

In order to enhance the sensitivity of conventional rapid test technique for the detection of swine-origin influenza A (H1N1) viruses (S-OIV), we used a paired surface plasma waves biosensor (PSPWB) based on SPR in conjunction with an optical heterodyne technique. Experimentally, PSPWB showed a 125-fold improvement at least in the S-OIV detection as compared to conventional enzyme linked immunosorbent assay. Moreover, the detection limit of the PSPWB for the S-OIV detection was enhanced 250-fold in buffer at least in comparison with that of conventional rapid influenza diagnostic test.

Monday 2 August

Time: 1:50 PM - 2:20 PM
Micro- and nanoparticle trapping and manipulation using surface plasmons and diffractive optics (Invited Paper)
Paper 7762-19
Author(s): Kenneth B. Crozier, Stanford Univ. (United States)

Field enhancement from surface plasmon structures presents new opportunities for optical manipulation. We demonstrate the propulsion of gold nanoparticles using surface plasmon polaritons (SPPs). SPPs are excited on a thin gold film. The resultant evanescent field draws nanoparticles toward the film, where they are propelled along by the optical scattering force. We also review related work on Fresnel zone plate optical tweezers. We show that these offer comparable performance to conventional optical tweezers, but with considerably smaller footprints.

Time: 3:30 PM - 4:00 PM
Optical metamaterials *(Invited Paper)*
Paper 7756-5
Author(s): Xiang Zhang, Univ. of California, Berkeley (United States)

Metamaterials are artificially designed subwavelength composites that possess extraordinary properties not existing in naturally occurring materials. In particular, they can alter the propagation of electromagnetic waves resulting in negative refraction, subwavelength focusing and even in cloaking of macroscopic objects. Such unusual

properties can be obtained by a careful design of dielectric or metal-dielectric composites on a deep sub-wavelength scale. The metamaterials may have profound impact in wide range of applications such as nano-scale imaging, nanolithography, and integrated nano photonics. I will discuss a few recent experiments demonstrating intriguing phenomena associated with Metamaterials. These include subdiffraction limit imaging and focusing, low-loss and broad-band negative-refraction of visible light, negative-index metamaterials and the first cloak operating at optical frequencies; an all-dielectric "carpet cloak" with broad-band and low-loss performance. I will also present our recent demonstration of sub-wavelength plasmonic laser.

Time: 3:30 PM - 4:00 PM
Spin transport in graphene (Invited Paper)
Paper 7760-17
Author(s): Masashi Shiraishi, Osaka Univ. (Japan) and Japan Science and Technology Agency (Japan)

Spintronics using graphene has been attracting many people. In 2007, several groups including our group have succeeded in observing spin injection signals and generating a pure spin current at room temperature [1-3]. In this talk, I introduce how to generate a spin current, unprecedented robustness of spin polarization of injected spins and degradation mechanisms in graphene spin valves [1,4,5]. In addition, I also introduce gate-voltage-induced modulation of the spin signals as theory predicts[6].
[1]M. Ohishi, M. Shiraishi et al., Jpn. J. Appl. Phys. 2007. [2] N. Tomboros et al., Nature 2007. [3] S. Cho et al., APL 2007. [4] M. Shiraishi et al., Adv. Func. Mat. 2009. [5] K. Muramoto, M. Shiraishi et al., APEX 2009. [6] N. Mitoma, M. Shiraishi et al., in preparation.

Time: 4:30 PM - 4:50 PM
Dielectric optical invisibility cloaks
Paper 7756-7
Author(s): John Blair, Georgia Institute of Technology (United States); Venkata A. Tamma, Won Park, Univ. of Colorado at Boulder (United States); Chris J. Summers, Georgia Institute of Technology (United States)

Transformation optical techniques can be applied to photonic crystal structures to create new optical invisibility cloaking devices. A recent design known as the 'carpet' cloak, compresses a curved reflective surface into a flat reflective surface, effectively shielding objects behind the curved area with respect to the incoming radiation source. This structure consists only of high index dielectrics, and operates in the 1400-1600nm wavelength range. A discussion of the design method, simulation analysis, device fabrication, and near field optical microscopy (NSOM) characterization results will be presented. Improvements to device performance through the infiltration of optical materials are currently under investigation.

Tuesday 3 August

Time: 8:00 AM - 8:30 AM
Sub shot noise quantum imaging (Invited Paper)
Paper 7815-1
Author(s): Marco Genovese, Istituto Nazionale di Ricerca Metrologica (Italy)

Quantum properties of the optical field represent a resource of the utmost relevance for the development of quantum technologies. A very interesting example is offered by the possibility of sub shot noise measurements with quantum optical states. In this talk we will present the first experimental realisation of sub shot noise imaging. Furthermore, we will describe new developments toward sub shot noise measurements both by exploiting PDC and 4-wave mixing techniques.

Time: 8:00 AM - 8:30 AM
Quantum rods and dots metal oxide structures and devices for direct solar water splitting (Invited Paper)
Paper 7770-1
Author(s): Lionel Vayssieres, National Institute for Materials Science (Japan)

If one considers the largest geographically balanced free resource available on earth, that is seawater, and the amount of sunlight energy striking our planet per hour, the direct solar-to-hydrogen conversion by photo-oxidation of water is a very straightforward solution for a clean, renewable and sustainable generation of hydrogen. Novel low cost visible light-active semiconductors based on quantum rods and dots of metal oxides have been fabricated at low cost in a attempt to contribute to the energy challenge.

Time: 8:30 AM - 9:40 AM
Lifetime and stability of organic solar cells (Invited Paper)
Paper 7777-1
Author(s): Kion Norrman, Risø National Lab. (Denmark)

Organic solar cells have exhibited significant improvements in a relatively short period of time. Progress within operation stability and shelf lifetime has in particularly been convincing, which undoubtedly has pushed the technology closer to a successful commercialization. However, further improvement is needed for the successful application of the devices in real life applications. Topics related to lifetime and stability will be addressed such as the need for: (i) detailed knowledge of how devices break down, (ii) methods to study failure mechanism, and (iii) methods to study, compare and standardize device stability.

Time: 8:50 AM - 9:20 AM
Development of a new system for utility-scale CPV *(Keynote Presentation)*
Paper 7769-2
Author(s): Roger P. Angel, Thomas E. Connors, Warren B. Davison, Blain H. Olbert, The Univ. of Arizona (United States)

The University of Arizona is developing a new approach to CPV at utility-scale using triple junction cells, aimed at an energy price of $0.05/kWh. Results will be presented demonstrating progress in three innovative areas: 1) Manufacture of large, back-silvered, square dish primary reflectors from single 3mx3m squares of flat glass. 2) Use of a unique spherical field lens of fused silica at each dish focus to relay concentrated light evenly at very high concentration (1000x) across a compact concave array of cells. 3) Reflectors and receivers rigidly coaligned in a unique, ultralightweight steel spaceframe that is pointed at the sun.

Time: 8:55 AM - 9:10 AM
Considerations for low cost, reliable and durable packaging
Paper 7773-1
Author(s): Neelkanth G. Dhere, Univ. of Central Florida (United States)

Organic solar cells have potential for the lowest cost in the long run. They are also most vulnerable to humidity, high temperature, etc followed by CdTe and CIGS solar cells. Barrier polymer/dielectric multilayers, ultrabarriers, or "dyad's" suitable for durable organic light emitting diodes have been developed. A fairly flexible, opaque layer applied directly on the back side can probably provide an adequate cost-effective protection from the back side. Therefore, it is essential to develop an economic, easy to clean, scratch resistant,

antireflection, passivating coating combined with the transparent, polymer/dielectric multilayers, all deposited directly on the front surface of the cell.

Time: 10:00 AM - 10:30 AM
Semiconductor plasmon laser (Invited Paper)
Paper 7757-29
Author(s): Volker J. Sorger, Rupert F. Oulton, Thomas Zentgraf, Univ. of California, Berkeley (United States); Ren-Min Ma, Peking Univ. (China); Christopher W. Gladden, Univ. of California, Berkeley (United States); Lun Dai, Peking Univ. (China); Guy Bartal, Xiang Zhang, Univ. of California, Berkeley (United States)

This first demonstration of a semiconductor plasmon laser exhibits strong sub-wavelength field confinement. These nanowire-based plasmonic lasers are not subjected to diffraction limitations, hence can operate below the photonic mode cut-off diameter of purely dielectric nanowire lasers. An experimental proven non-resonant Purcell enhancement of 6 gives some inside in the underlying physical mechanism. Plasmonic lasers thus offer the possibility of exploring extreme interactions between light and matter, opening up new avenues in the fields of active photonic circuits, bio-sensing and quantum information technology.

Time: 10:30 AM - 12:00 PM
Exploiting optical resonance and plasmonics for molecular manipulation and analysis (Invited Paper)
Paper 7759-31
Author(s): David Erickson, Cornell Univ. (United States)

In this talk I will discuss the use of optically resonant and plasmonic devices for molecular detection and manipulation. Areas of application will include: blood protein sensing, pathogen detection, single molecule studies and directed nanoassembly.

Time: 10:40 AM - 11:10 AM
Nanotechnologies for efficient solar and wind energy harvesting and storage (Invited Paper)
Paper 7764-7
Author(s): Louay A. Eldada, HelioVolt Corp. (United States)

We describe nanotechnologies used to improve the efficient harvest of energy from the Sun and the wind, and the efficient storage of energy in secondary batteries and ultracapacitors, for use in a variety of applications including smart grids, electric vehicles, green buildings, and portable electronics.

Time: 11:30 AM - 12:00 PM
The likelihood of microbial life on Mars (Invited Paper)
Paper 7819-15
Author(s): Joseph D. Miller, The Univ. of Southern California (United States); Marianne J. Case, Univ. of California, Irvine (United States); Gilbert V. Levin, Arizona State Univ. (United States)

Interpretation of the Viking labeled release (LR) data has been a source of controversy for over 30 years. New analytical approaches have suggested that the presence of circadian rhythmicity, a reliable biosignature, in the gas release data imply the gas was probably of biological origin. Plausible simulations suggest a significant component of the gas could have been methane. Extrapolation of gas release rates based on release kinetics inferred from the Viking LR observations further suggest a reasonably sized global population of

methanogens. Furthermore, terrestrial rates of methane production by methanogens could easily account for observed methane in the Martian atmosphere.

Time: 1:30 PM - 3:20 PM
Photochemical activities of nitrogen doped rutile and anatase surfaces (Invited Paper)
Paper 7770-6
Author(s): Michael A. Henderson, Pacific Northwest National Lab. (United States)

One of the major limitations of TiO2 as a photocatalysis is that it absorbs relatively little of the solar spectrum. One possibility around this problem is anion doping. This presentation highlights insights into anion doping of TiO2 using single crystals as models. The solubility limit of N in single crystal TiO2 is ~2 at.%. N-substitutes for lattice O and adds 2p states above the valence band maximum, reducing the interband optical absorption threshold from 3.0/3.2 eV to ~2.5 eV. The photoactivities of structurally well-defined N-doped TiO2 rutile and anatase films were examine in the UV and visible.

Time: 1:55 PM - 2:40 PM
Coherent properties in complex plasmonic nanoparticles and nanostructures (Keynote Presentation) (Keynote Presentation)
Paper 7757-33
Author(s): Lisa V. Brown, S. Mukherjee, Nche T. Fofang, Britt Lassiter, A. Govorov, Peter J. Nordlander, Naomi J. Halas, Rice Univ. (United States)

Designing coherent effects, such as Fano resonances or electromagnetically induced transparency, into individual plasmonic nanoparticles and their assemblies is a topic of intense current interest. Reduced symmetry enables the coupling between superradiant and subradiant modes in the same structure, providing an important mechanism that gives rise to these effects. Local asymmetries, such as defects, on individual symmetric nanoparticles can also serve to enhance this mode-mode coupling, giving rise to Fano resonances in otherwise symmetric geometries where such phenomena would not be excitable. Asymmetric nanoparticle assemblies such as plasmonic heterodimers or plasmonic clusters give rise to a remarkably rich range of coherent phenomena, including avoided crossing behavior and optical nanodiode effects. Combining excitonic and plasmonic media in the same nanoscale complex gives rise to mixed plasmon and excitonic modes with dramatic coupled-oscillator dynamics.

Time: 2:50 PM - 3:10 PM
Wireless health information and hardware technology and systems
Paper 7759-37
Author(s): Ani Nahapetian, Majid Sarrafzadeh, Univ. of California, Los Angeles (United States)

One of the most urgent and daunting tasks of our time is provide quality healthcare in the face of increasing incidence of disease, an aging population, soaring costs, and declining public funding. A new community of researchers at UCLA has been formed with the Schools of Medicine and the Center for Health Sciences, Engineering, Public Health, Nursing and Business, and others to create a new low-cost healthcare model that applies technology to bring affordable care within the reach of every citizen. This model holds promise of revolutionizing the accessibility, quality, financing, and delivery of healthcare in much the same way that low-cost cellular phone technology has dramatically changed telecommunications worldwide. Wireless Health combines this ubiquitous wireless access with personal sensing technology and a foundation in medical research to support a large population with a powerful, low cost healthcare service.

Time: 3:30 PM - 4:00 PM
Printed, flexible solar cells (Invited Paper)
Paper 7772-57

(No abstract available)

Time: 3:50 PM - 4:20 PM
Bandgap engineering of metal oxides for PEC H2 production from water (Invited Paper)
Paper 7770-10
Author(s): Yanfa Yan, Heli Wang, Kwang-Soon Ahn, Sudhakar Shet, Todd G. Deutsch, John A. Turner, Mowafak M. Al-Jassim, National Renewable Energy Lab. (United States)

A common method used to reduce the bandgap of transition metal oxides is the incorporation of anion impurities such as C, S, and N. Incorporation of these impurities has typically resulted in bandgap reduced thin films. To achieve significant bandgap reduction, high concentration of impurities has to be incorporated, which often lead to metal oxide films with high concentration of recombination center. As a result, the metal oxides with significantly reduced bandgap usually exhibit poor photoresponse. We have developed a passive co-doping approach to address these problems. This approach has the following benefits: (1) the solubility of the dopants can be significantly enhanced; (a) recombination defects are dramatically reduced, and (3) the material quality can be improved. We will use ZnO as a prototype material to demonstrate the benefits of passive co-doping for transition metal oxides in PEC application.

Time: 4:05 PM - 4:30 PM
Production and deployment of high performance CPV panels for the utility scale marketplace (Invited Paper)
Paper 7769-11
Author(s): Adam Plesniak, Guy Martins, John Hall, The Boeing Co. (United States)

The DoE funded Solar Energy Technology Program has been operating successfully since March 2007 within the Research and Technology division of The Boeing Company. June 2010 marks the close of the partnership with production and installation completion of the program's first 100kW power plant at California State University at Northridge. Manufacturing, deployment and installation activities as well as power plant performance specifications are discussed. Characteristics of this first power plant and future commercialization plans for this exciting CPV technology are visited.

Time: 4:30 PM - 5:00 PM
Wire texture silicon solar cells (Invited Paper)
Paper 7772-21
Author(s): Supratik Guha, Oki Gunawan, Kejia Wang, Naim Moumen, George Tulevski, Hisham Muhammed, IBM Thomas J. Watson Research Ctr. (United States)

Silicon nanowire or micro-wire array based solar cells offer enhanced light absorption, and therefore the promise of savings in materials costs. In order to be practical, however, silicon nanowire devices have to demonstrate promising net power conversion efficiencies. In this talk we describe experimental results from silicon wire texture solar cells created using both vapor liquid solid (VLS), as well as top down etching techniques. We demonstrate wire texture solar cells that outperform their planar counterparts in terms of net power conversion efficiency, as well as short circuit currents. We also show that device series resistance is an important drawback that nanowire devices can suffer from.

Time: 5:00 PM - 5:20 PM
Semiconductor nanowire optical antenna solar absorbers
Paper 7772-29
Author(s): Linyou Cao, Mark L. Brongersma, Stanford Univ. (United States)

Photon management (PM) has emerged as a powerful additional means to boost energy conversion efficiencies. Here, we demonstrate an entirely new PM strategy that capitalizes on strong broadband optical antenna effects in one-dimensional semiconductor nanostructures to dramatically enhance absorption of sunlight. We propose that by patterning the silicon layer in a thin film PV cell into an array of nanowires (NWs), one can boost the absorption for solar radiation by250% increase in absorption per unit volume material. The results provide a clear, intuitive guidance for the design of efficient solar cells.

Time: 5:00 PM - 5:30 PM
Graphene spintronics (Invited Paper)
Paper 7760-33
Author(s): Niko Tombros, Univ. of Groningen (Netherlands)

I will give an overview of electron spin injection, spin transport, spin precession and spin manipulation in graphene field effect devices with ferromagnetic contacts. I will show that: a) Spins can be transported through a graphene layer with a spin relaxation length of about 1.5 micrometer. By applying a perpendicular magnetic field Hanle spin precession can be studied and information about spin relaxation and the carrier diffusion can be obtained [1]. b) By applying a large DC electric field the transport of spins between injector and detector can be manipulated using carrier drift [2]. c) The spin relaxation is found to be slightly anisotropic, with spins directed perpendicular to the graphene plane relaxing faster than spins directed in the plane [2]. d) We have observed a scaling between the spin relaxation times and lengths and the carrier mobility in graphene [2].
[1] N. Tombros et al., Nature 448, 571 (2007)
[2] M. Popinciuc et al., Phys. Rev. B 80, 214427 (2009)

Time: 5:50 PM - 6:10 PM
Plasmon-mediated decay rate engineering of erbium-doped silicon-rich silicon oxide in MOS waveguides
Paper 7757-41
Author(s): Aaron C. Hryciw, Stanford Univ. (United States); Oleksandr Savchyn, Pieter G. Kik, CREOL, The College of Optics and Photonics, Univ. of Central Florida (United States); Mark L. Brongersma, Stanford Univ. (United States)

Silicon-based light-emitting materials such as rare-earth-doped Si nanocomposites are attractive candidates for CMOS-compatible, on-chip light sources, but can be plagued by long radiative recombination lifetimes and/or low internal quantum efficiencies. However, by incorporating such a light emitter into a metal-oxide-semiconductor-oxide waveguide architecture, the radiative emission rate can be increased drastically over a wide wavelength range via coupling to propagating surface plasmon-polariton modes. We investigate this device architecture experimentally using erbium-doped silicon-rich silicon oxide as the light emitter, and theoretically using a semi-classical oscillating dipole model.

Wednesday 4 August

Time: 8:00 AM - 10:10 AM
Nanostructured hematite for hydrogen production (Invited Paper)
Paper 7770-14
Author(s): Kevin Sivula, Michael Grätzel, Ecole Polytechnique Fédérale de Lausanne (Switzerland)

With a favorable band-gap of 2.0 - 2.2 eV, chemical stability in aqueous environments, and ample abundance, using Hematite (alpha-Fe2O3) as a watersplitting photocatalyst to produce hydrogen at a scale corresponding to the world energy demand is realistic. However, its performance as a photoanode has been limited by a short excited state lifetime and poor charge carrier mobility as compared to the light penetration depth. These limitations can be overcome with nanostructuring approaches. In this work we report progress on three approaches: atmospheric pressure chemical vapor deposition (APCVD), extremely thin absorber electrodes, and mesoporous electrodes prepared by a solution-based colloidal method.

Time: 8:45 AM - 9:30 AM
Plasmonics for optical field localization and applications (Keynote Presentation)
Paper 7757-43
Author(s): Yeshaiahu Fainman, Univ. of California, San Diego (United States)

We explore metal-dielectric and metal-dielectric-semiconductor nano-plasmonic structures for localization and resonant transmission of optical fields, investigate fabrication and integration of optofluidic nano-plasmonic systems and explore their applications for biochemical sensing.

Time: 9:30 AM - 9:50 AM
Advanced thermal management materials for concentrator photovoltaic arrays
Paper 7769-16
Author(s): Carl H. Zweben, Advanced Thermal Materials (United States)

Thermal management and thermal stresses affect photovoltaic performance, efficiency and lifetime. Traditional packaging materials have serious deficiencies. Copper has a high CTE, causing thermal stresses. Compliant soft solders and polymeric TIMs have major drawbacks. Traditional low-CTE materials have low thermal conductivities. New packaging materials have low CTEs and thermal conductivities up to 4X copper. Some are cheaper than copper. In this paper, we survey the six categories of advanced packaging materials, including properties, state of maturity, cost and applications. We also review a concentrator application in which an advanced metal matrix composite with tailored CTE eliminated solder joint failure.

Time: 9:30 AM - 9:50 AM
Extremely low-loss slow-light modes in plasmonic dielectric hybrid systems
Paper 7757-44
Author(s): Atsushi Ishikawa, Rupert F. Oulton, Univ. of California, Berkeley (United States); Thomas Zentgraf, Univ. of California, Berkeley (United States) and Univ. Stuttgart (Germany); Xiang Zhang, Univ. of California, Berkeley (United States) and Lawrence Berkeley National Lab. (United States)

A new class of optical modes arising from the hybridization between one localized plasmon and two orthogonal waveguide modes is described. Of particular interest is our observation that these hybrid modes simultaneously exhibit extremely low-loss and highly dispersive characteristics, which translate into slow light propagation. We propose this is a new type of classical analogs of the electromagnetically induced transparency in an atomic system. The dispersion characteristics of the modes can be entirely controlled by tuning the coupling strengths between the plasmon and waveguide modes while the mode losses remain the same. An application to slow-light waveguide devices is discussed.

Time: 11:50 AM - 12:10 PM

Enhancing spontaneous emission in III-V semiconductor plasmonic core-shell nanoresonators

Paper 7756-29

Author(s): Carrie E. Hofmann, California Institute of Technology (United States); Francisco Javier García de Abajo, Consejo Superior de Investigaciones Científicas (Spain); Harry A. Atwater, Jr., California Institute of Technology (United States)

Plasmonic nanocavities present a unique opportunity to confine resonator modes to deeply subwavelength volumes and to engineer light emission properties on the nanoscale. Here, we explore resonators consisting of semiconductor cores (GaAs, AlGaAs, InGaN) coated with Ag using a combination of theoretical calculations and optical microscopy. The core-shell nanoresonator geometry allows precise control of the local density of optical states, and thus the radiative emission rate, by changing the dimensions of the core. For all resonators, we see very high confinement within the core and moderate quality factors (Q=30-50), resulting in high Q/V, large enhancements in the emission rate (250x-8000x). Additionally, both time- and spatially-resolved optical characterization of fabricated semiconductor-metal core-shell nanoresonators will be discussed. This work demonstrates the promise of subwavelength plasmonic structures for realizing bright, nanoscale LEDs.

Time: 1:40 PM - 2:20 PM

Progress of DNA biotronics and other applications (Keynote Presentation) (Keynote Presentation)

Paper 7765-8

Author(s): Naoya Ogata, Chitose Institute of Science and Technology (Japan)

(No abstract available)

Time: 2:00 PM - 2:30 PM

Spin-Hall and quantum spin-Hall effects at the nanoscale (Invited Paper)

Paper 7760-41

Author(s): Ewelina Hankiewicz, Julius-Maximilians-Univ. Würzburg (Germany)

The spin-Hall and the quantum spin-Hall (QSH) phenomena can become an avenue for new spin devices. The spin-Hall effect is the generation of a spin-current transverse to an electric field in the conducting material, while the QSH effect characterizes a topological insulator with the gapless spin edge channels on the boundary. I will present our theoretical proposal to generate and detect the spin-Hall/QSH effects in transport by using purely electrical means. In particular, I will discuss a new phenomenon: conversion of spin polarization of QSH edge channels into an electric signal via inverse spin-Hall effect in hybrid metal/insulator structures.

Time: 2:50 PM - 3:10 PM

Characterization of spray-coated, nanostructured zinc oxide films for photovoltaic applications

Paper 7766-14

Author(s): Saahil Mehra, Mark G. Christoforo, Rodrigo J. Noriega-Manez, Evelyn Nguyen, Sujay Phadke, Alberto Salleo, Stanford Univ. (United States)

We explore the light-diffusing properties of nanostructured zinc oxide films fabricated on glass substrates using a scalable pneumatic spray coating process. Synthesis of hexagonal-base zinc oxide nanostructures with controlled size distributions and morphologies is achieved using low-temperature, solution-based decomposition of zinc acetate in organic solvents. We further demonstrate a systematic optimization of spray-coating process variables for nanostructured film deposition with light diffusing and transparent electrode applications, exhibiting control over film uniformity, thickness, and the resulting optical

properties. The effects of morphology, size and annealing temperatures on light diffusing properties of sprayed films were quantified using diffuse transmission/reflection measurements and SEM.

Time: 3:30 PM - 4:15 PM
Nano-antenna control of single photon emitters (Keynote Presentation) (Keynote Presentation)
Paper 7757-53
Author(s): Niek F. van Hulst, ICFO - Instituto de Ciencias Fotónicas (Spain)

Nano-antennas in close proximity to single photon emitters (molecules, Q-dots, color centers) offer unique opportunities for the control of spectra, radiative rate, emission direction, polarization and fs dynamics. Several recent advances will be presented, based on combination of phase controlled broad band excitation, advanced nanofabrication and single molecule spectroscopy: Phase shaped excitation of single molecules and nanoantennas, revealing dynamics on 10 fs scale, dephasing times and control of field concentration at local antenna hot spots; resonant directional photon emission of single quantum systems.

Time: 5:25 PM - 5:45 PM
Plasmonic resonator antennas for enhanced light emission and detection
Paper 7757-57
Author(s): Edward S. Barnard, Mark L. Brongersma, Stanford Univ. (United States)

A combined theoretical and experimental study of detectors and emitters enhanced by wavelength-scale plasmonic resonator antennas is presented. Using full-field electromagnetic simulations and analytical optical antenna models, we derive simple and intuitive design rules to achieve antennas with a desired set of optical properties based on their geometric properties. With these design rules, we have constructed resonance maps that allow a designer to choose an antenna structure that provides desired resonant properties for a specific application. We then apply these design rules to create antennas that resonantly enhance absorption on thin silicon detectors and enhance emission of Si nanocrystal films.

Thursday 5 August

Time: 8:00 AM - 10:25 AM
Plasmonic, semiconductor, and dielectric building blocks for nanophotonics (Keynote Presentation) (Keynote Presentation)
Paper 7757-59
Author(s): Mark L. Brongersma, Stanford Univ. (United States)

Metamaterials and nanophotonic devices are most commonly constructed from metallic (i.e. plasmonic) nanostructures. However, recent research has begun to also exploit the optical resonances of high-permittivity semiconductor and dielectric nanostructures to realize similar optical functionalities. In this talk, I will illustrate the use of plasmonic, semiconductor, and dielectric nanostructures in a variety of applications (nanoscale and thermal sources, high-speed modulators, and detectors) and discuss their relative strengths and weaknesses.

Date: Thursday 5 August
Time: 8:00 AM - 8:40 AM
Photoelectrochemical production of hydrogen: issues and possibilities (Keynote Presentation) (Keynote Presentation)
Paper 7770-30

Author(s): John A. Turner, National Renewable Energy Lab. (United States)

(No abstract available)

Time: 10:00 AM – 10:30 AM
Active plasmonic components employing extreme light concentration
Paper 7756-37
Author(s): Mark L. Brongersma, Stanford Univ. (United States)

Many successful plasmonics applications make use of at least one of two unique properties of metals. One special property of metals is that they can perform simultaneous electronic and optical functions. The second unique property of metallic structures is their ability to concentrate light to nanoscale dimensions. These properties enable a variety of new passive and active chipscale components for information transport and sensing. I will discuss the operation of several of these devices in detail. Finally, I will show how some plasmonic devices can be fabricated right now using current CMOS integrated circuit technologies.

Time: 12:10 PM - 12:30 PM
A compact silicon photonic waveguide modulator based on the vanadium dioxide metal-insulator phase transition
Paper 7756-44
Author(s): Ryan M. Briggs, Imogen M. Pryce, Harry A. Atwater, Jr., California Institute of Technology (United States)

The thermochromic phase transition of vanadium dioxide has been explored in recent years for its potential applications in active optical devices. Crystalline vanadium dioxide can be transformed from a relatively transparent insulating state to a metallic phase upon application of thermal, optical, or electrical stimuli. We integrate lithographically patterned vanadium dioxide thin films with silicon-on-insulator photonic waveguides in order to demonstrate a compact modulator for use in photonic circuits. We show thermally induced optical modulation in excess of 6.5 dB at 1550 nm, with 2 dB insertion loss. Implementations based on high-speed optical and electrical switching will be discussed.

Time: 1:00 PM - 1:45 PM
Chemistry, life, and the search for aliens (Overview Presentation) (Invited Paper)
Paper 7819-39
Author(s): Steven Benner, Foundation for Applied Molecular Evolution, The Westheimer Institute for Science and Technology (United States)

Those searching for signatures of life in the cosmos, including any cryptic biosphere that might exist unnoticed here on Earth, must have a "theory of life", a concept of what forms biology might take given the constraints of physical and chemical law. Assuming that life is a self-sustaining chemical system capable of Darwinian evolution, various experimental studies with proteins and nucleic acids, including their analogs, have provided several statements about what chemical forms might possibly support natural selection superimposed upon random variation, and still be compatible with physical and chemical law. These include the "polyelectrolyte theory of the gene", the usefulness of certain kinds of regularity in genetic and catalytic biopolymers that helps them be evolvable, and the nature of molecular "structure spaces" that are explored by variation and selection. Each of these generates explicit procedures that might be sent to Mars, Titan, or elsewhere to search for life, including "weird life" (of the type that might live in Titan's oceans at 94 K) and life on Earth inhabiting a cryptic biosphere.

Time: 1:40 PM - 2:10 PM
Experiments on transformation optics in three dimensions (Invited Paper)

Paper 7754-69
Author(s): Nicolas Stenger, Tolga Ergin, Martin Wegener, Karlsruhe Institute of Technology (Germany)

Transformation optics has been shown to be a powerful scientific tool for shaping optical space and hence designing highly unusual optical devices, such as invisibility-cloaking structures.
So far, these invisibility cloaking devices have been two-dimensional waveguide structures working at microwave and optical frequencies. There, the notion "invisibility cloaking" has to be taken with a grain of salt as the "invisible" becomes immediately visible when inspected from the (normal) third dimension.
In this presentation, we report the experimental realization of a three-dimensional version of the carpet cloak operating with large bandwidth at around 2-µm wavelength (unpublished).