Semiconductor Nano-pillars for Opto-electronic Applications

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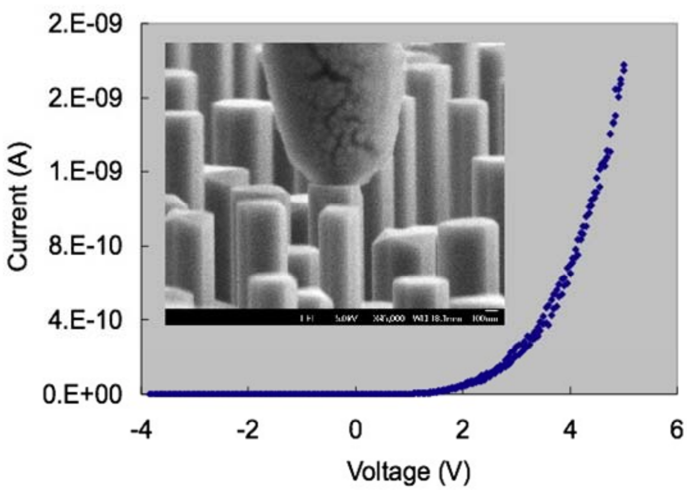
Abstract

Advances in the technology for fabrication of quantum dots and nano-wires have resulted in electronic devices with improved optical performance due to the quantized carrier energies and decreased phonon density of states. The small dimensions of these structures result in electronic confinement in multiple dimensions and decrease rates of electron-phonon scattering, reducing non-radiative recombination and opening the door to higher quantum efficiency opto-electronics operating at longer wavelengths. Our group has pioneered a unique technology for accurately positioning quantum dots relative to registration marks for subsequent lithography steps. We are now studying the growth of uniform arrays of nano-pillars with diameters from 100nm to 200nm and heights of several microns by MOCVD selective area epitaxy on patterned Silicon and Gallium Arsenide substrates. Nano-pillars containing axial and radial core-shell heterostructures with well defined interfaces have been demonstrated paving the way for future device integration.



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Quantum Dot Solar Cells

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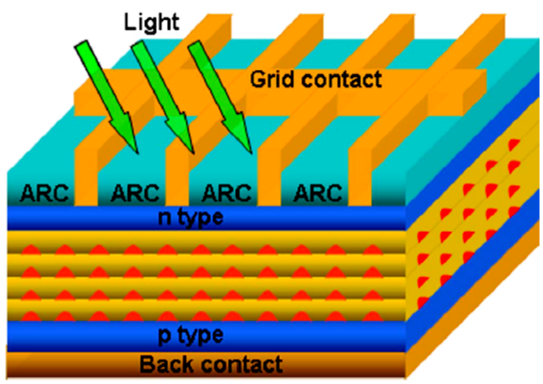
Abstract

Quantum dots embedded in a single junction solar cell offer the advantage of tuneable bandgaps and by varying the size of a quantum dot it is possible to adjust the wavelength of the light absorbed. In quantum dot solar cells multiple stacks of QD layers have been employed in the i-region of p-i-n solar cells. In this work, both InAs/GaAs [1] (type I) and GaSb/GaAs [2] (type II) QDs have been studied for the application in QD solar cells. The performance of these cells are studied via I-V and spectral response measurements. In InAs QD solar cells, strain compensation has been studied for better device performance and higher conversion efficiency. These QD cells with strain compensation exhibit higher short circuit current, open circuit voltage and fill factors indicating the reduced defects in device. The spectral response (up to 1100 nm) of these QD cells has increased beyond the response of the GaAs control cell (950 nm). The GaSb QD solar cell exhibit a spectral response up to 1350 nm compared that of control cell. This higher wavelength response can be attributed to the QDs while the GaSb QD cells exhibit larger leakage currents due to the presence of defects. Also a design for an optimum QD bandstructure for carrier multiplication has been investigated.



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Dispersion Engineered Metamaterial-based Transmission Line for Conformal Surface Application

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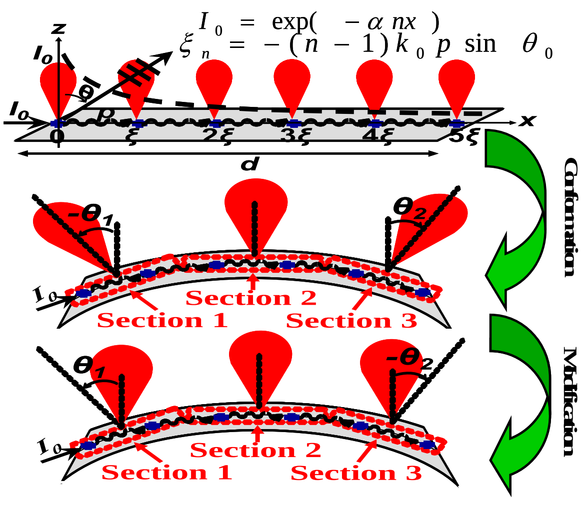
Abstract

In this presentation, a novel conformal metamaterial-based transmission line (TL) is introduced and the effect of conformation is investigated. The presented structure is a 25 unit-cell composite right/left-handed (CRLH) TL that is conformed on a cylindrical object with a radius of 20.0 cm. The effect of conformation on this CRLH TL is investigated for two situations: slow-wave mode operation and fast-wave mode operation. It is shown that conformation has insignificant effect on the structure's performance in terms of S-parameters when the structure is operating in the slow-wave region. Conversely, when the CRLH TL is operating in the fast-wave region conformation will result in significant performance changes. These changes occur in terms of the leaky-wave radiation characteristics of the structure. In the later case, dispersion engineering is employed to modify the conformal structure such that it provides comparable performance to the planar version in terms of radiation characteristics.



The Effect of conformation and proposed modification method for the conformal CRLH TL.

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Nonlinear Behavior of Electron Plasma Waves Relevant to Stimulated Raman Scattering Using Computer Simulation

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Abstract

The National Ignition Facility (NIF) at Lawrence Livermore National Laboratory is scheduled to begin operation in 2010. NIF, in a process called inertial confinement fusion (ICF)[1], will use lasers to compress and heat a target to high enough densities and temperatures that nuclear fusion can occur. Among the many challenges facing ICF experiments is the control of laser-plasma instabilities such as stimulated Raman scattering (SRS)[2], the decay of the laser into a backscattered light wave and a forward going electron plasma wave. SRS is detrimental to ICF because it can reflect incident laser energy and generate hot electrons that preheat the target, both of which decrease the fusion gain. Much work has been done to understand SRS for NIF conditions, but a theoretical model remains elusive due to several incompletely understood, nonlinear plasma wave processes[3]. Our group has studied these effects using electromagnetic particle-in-cell (PIC) simulations, but the complex interplay of plasma wave nonlinearities makes the analysis difficult. Using externally-driven electrostatic PIC simulations, we have isolated these effects for detailed study and we present a few of the results in this talk. With 1D simulations, we show that finite-length plasma wave packets 'etch' away as resonant particles interact with the packet's rear edge. In two dimensions, a conceptually similar interaction leads waves with finite transverse width to localize around the wave's center. These effects are important for understanding SRS in ICF conditions because they can limit the plasma waves' lifetimes and change the long-time behavior of SRS.

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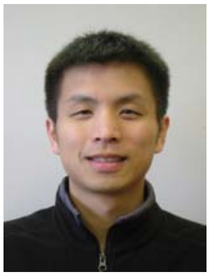
High Efficiency Power Amplifier for Complex Modulations based on Pulsed Load Modulation (PLM)



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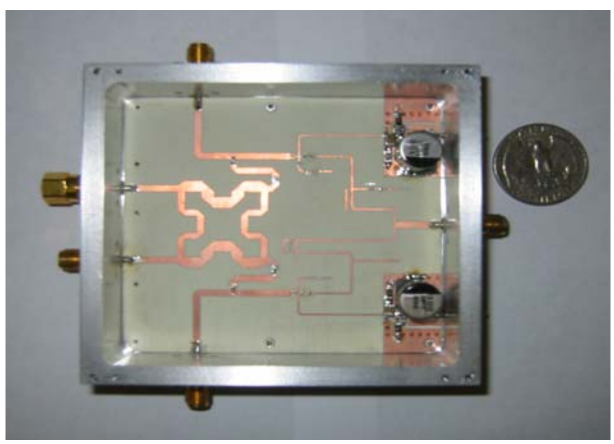
Abstract

Modern communications require transmitters with availability of output power, linearity and bandwidth. For digital modulation schemes, output signal amplitude is modulated and causing high peak to average power ratio. Therefore the average power efficiency of a power amplifier will be seriously degraded when non-constant envelope modulations are applied. Efficiency enhancement techniques based on load impedance modulation have shown its potential ability to restore power efficiency; however, analogue load modulation will introduce strong nonlinearity. A novel power amplifier technique, Pulsed Load Modulation (PLM) is proposed for high efficiency and high linearity amplification. Through this technique, load modulation can be realized in a digital fashion and the optimum efficiency can be maintained in a wide range of output power for high frequency power amplification. In this talk, a power amplifier module driven with Pulsed Load Modulation (PLM) scheme on 0.35um GaAs pHEMT technology will be present to demonstrate the improvement of efficiency over conventional power amplifier and the ability of PLM scheme on higher end of the microwave frequency application.



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