Strain-Controlled Shell Morphology On Quantum Rods

Ji BT, Panfil YE, Waiskopf N, Remennik S, Popov I, Banin U,
NATURE COMMUNICATIONS 10, 2 (JAN 2 2019)

Semiconductor heterostructure nanocrystals, especially with core/shell architectures, are important for numerous applications. Here we show that by decreasing the shell growth rate the morphology of ZnS shells on ZnSe quantum rods can be tuned from flat to islands-like, which decreases the interfacial strain energy. Further reduced growth speed, approaching the thermodynamic limit, leads to coherent shell growth forming unique helical-shell morphology. This reveals a template-free mechanism for induced chirality at the nanoscale. The helical morphology minimizes the sum of the strain and surface energy and maintains band gap emission due to its coherent core/shell interface without traps, unlike the other morphologies. Reaching the thermodynamic controlled growth regime for colloidal semiconductor core/shell nanocrystals thus offers morphologies with clear impact on their applicative potential.

https://www.nature.com/articles/s41467-018-07837-z

Tunneling Into The Vortex State Of NbSe2 With Van Der Waals Junctions

Dvir T, Aprili M, Quay CHL, Steinberg H,
NANO LETTERS 18, 12 (DEC 2018)

We have performed device-based tunneling spectroscopy of NbSe2 in the vortex state with a magnetic field applied both parallel and perpendicular to the a-b plane. Our devices consist of layered semiconductors placed on top of exfoliated NbSe2 using the van der Waals transfer technique. At zero field, the spectrum exhibits a hard gap, and the quasiparticle peak is split into low- and high-energy features. The two features, associated with the effective two-band nature of superconductivity in NbSe2, exhibit markedly distinct responses to the application of magnetic field, suggesting an order-of-magnitude difference in the spatial extent of the vortex cores of the two bands. At energies below the superconducting gap, the hard gap gives way to vortex bound Caroli de Gennes Matricon states, allowing the detection of individual vortices as they enter and exit the junction. Analysis of the subgap spectra upon application of parallel magnetic field allows us to track the process of vortex surface formation and spatial rearrangement in the bulk.

https://pubs.acs.org/doi/10.1021/acs.nanolett.8b03605
Fully Guided Electrically Controlled Exciton Polaritons

Liran D, Rosenberg I, West K, Pfeiffer L, Rapaport R,

ACS PHOTONICS  5, 11 (NOV 2018)

We demonstrate two types of waveguide structures that optically confine exciton-polaritons in two dimensions and act as polaritonic channels. We show a strong optical confinement in an etched rectangular waveguide that significantly increases the propagation distance of the polaritons and allows to direct them in curved trajectories. Also, we show low-loss optical guiding over a record-high of hundreds of microns, which is combined seamlessly with electrical control of the polaritons, in a strip waveguide formed by electrically conductive and optically transparent strips deposited on top of a planar waveguide. Both structures are scalable and easy to fabricate and offer new possibilities for designing complex polaritonic devices.

https://pubs.acs.org/doi/10.1021/acsphotonics.8b00922

The Role Of Surface Roughness In Plasmonic-Assisted Internal Photoemission Schottky Photodetectors

Grajower M, Levy U, Khurgin JB,

ACS PHOTONICS  5, 10 (OCT 2018)

Internal photoemission of charged carriers from metal to semiconductors plays an important role in diverse fields such as sub-bandgap photodetectors and catalysis. Typically, the quantum efficiency of this process is relatively low, posing a stringent limitation on its applicability. Here, we show that the efficiency of hot carrier injection from a metal into a semiconductor across a Schottky barrier can be enhanced by as much as an order of magnitude in the presence of surface roughness on the scale of a few atomic layers. Our results are obtained using a simple semianalytical theory and indicate that properly engineered plasmonic-assisted internal photoemission photodetectors can be a viable alternative in silicon photonics. Other applications, such as plasmonic-enhanced photocatalysis, can also benefit from these results.

https://pubs.acs.org/doi/10.1021/acsphotonics.8b00643
Exciton-polaritons are mutually interacting quantum hybridizations of confined photons and electronic excitations. Here, we demonstrate a system of optically guided, electrically polarized exciton-polaritons ("dipolaritons") that displays up to 200-fold enhancement of the polariton-polariton interaction strength compared to unpolarized polaritons. The magnitude of the dipolar interaction enhancement can be turned on and off and can be easily tuned over a very wide range by varying the applied polarizing electric field. The large interaction strengths and the very long propagation distances of these fully guided dipolaritons open up new opportunities for realizing complex quantum circuitry and quantum simulators, as well as topological states based on exciton-polaritons, for which the interactions between polaritons need to be large and spatially or temporally controlled. The results also raise fundamental questions on the origin of these large enhancements.

http://advances.sciencemag.org/content/4/10/eaat8880

We study experimentally and theoretically the interactions among ultrashort optical pulses in the soliton rain multiple-pulse dynamics of a fiber laser. The laser is mode locked by a graphene saturable absorber fabricated using the mechanical transfer technique. Dissipative optical solitons aggregate into pulse bunches that exhibit complex behavior, which includes acceleration and bidirectional motion in the moving reference frame. The drift speed and direction depend on the bunch size and relative location in the cavity, punctuated by abrupt changes under bunch collisions. We model the main effects using the recently proposed noise-mediated pulse interaction mechanism, and obtain a good agreement with experiments. This highlights the major role of long-range Casimir-like interactions over dynamical pattern formations within ultrafast lasers.

https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.121.133902
Complete Polarization Control In Multimode Fibers With Polarization And Mode Coupling

Xiong W, Hsu CW, Bromberg Y, Antonio-Lopez JE, Correa RA, Cao H,
LIGHT-SCIENCE & APPLICATIONS 7, 54 (AUG 8 2018)

Multimode optical fibers have seen increasing applications in communication, imaging, high-power lasers, and amplifiers. However, inherent imperfections and environmental perturbations cause random polarization and mode mixing, causing the output polarization states to be different from the input polarization states. This difference poses a serious issue for employing polarization-sensitive techniques to control light-matter interactions or nonlinear optical processes at the distal end of a fiber probe. Here, we demonstrate complete control of polarization states for all output channels by only manipulating the spatial wavefront of a laser beam into the fiber. Arbitrary polarization states for individual output channels are generated by wavefront shaping without constraining the input polarization. The strong coupling between the spatial and polarization degrees of freedom in a multimode fiber enables full polarization control with the spatial degrees of freedom alone; thus, wavefront shaping can transform a multimode fiber into a highly efficient reconfigurable matrix of waveplates for imaging and communication applications.

https://www.nature.com/articles/s41377-018-0047-4
Ultrafast Rogue Wave Patterns In Fiber Lasers
Klein A, Masri G, Duadi H, Sulimany K, Lib O, Steinberg H, Kolpakov SA, Fridman M,
OPTICA 5, 7 (JUL 20 2018)

Fiber lasers are convenient for studying extreme and rare events, such as rogue waves, thanks to the lasers' fast dynamics. Indeed, several types of rogue wave patterns were observed in fiber lasers at different time-scales: single peak, twin peak, and triple peak. We measured the statistics of these ultrafast rogue wave patterns with a time lens and developed a numerical model proving that the patterns of the ultrafast rogue waves were generated by the non-instantaneous relaxation of the saturable absorber together with the polarization mode dispersion of the cavity. Our results indicate that the dynamics of the saturable absorber is directly related to the dynamics of ultrafast extreme events in lasers.

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Plasmonic Enhanced EIT And Velocity Selective Optical Pumping Measurements With Atomic Vapor
Talker E, Arora P, Barash Y, Stern L, Levy U,
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In this work, we experimentally observe for the first time nanoscale plasmonic enhanced Electromagnetically Induced Transparency (EIT) and Velocity Selective Optical Pumping (VSOP) effects in miniaturized Integrated Quantum Plasmonic Device (IQPD) for D-2 transitions in rubidium (Rb). Our device consists of a vapor cell integrated on top of a prism coated with a thin layer of metal. This configuration is known to allow efficient excitation of Surface Plasmon Resonance (SPR). The evanescent field of the surface plasmon mode interacts with the atomic media in close vicinity to the metal. In spite of the limited interaction length between SPR and Rb atoms, the signature of EIT along with VSOP signals could be clearly observed in our miniaturized IQPD under proper conditions of pump and probe intensities. A gradual decrease in the contrast of the plasmonic enhanced EIT and VSOP signals was observed as the excitation was detuned from the SPR critical angle, due to reduction in electromagnetic field enhancement, leading to a reduced interaction of the evanescent field with the atomic vapor media. Following the demonstration of these effects, we also present a detailed model revealing the mechanisms and the origin of plasmonic enhanced EIT and VSOP effects in our system. The model, which is based on the Bloch equations, is in good agreement with the
observed experimental results. The obtained results are regarded as an important step in the quest for the realization of nanoscale quantum plasmonic effects and devices.

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