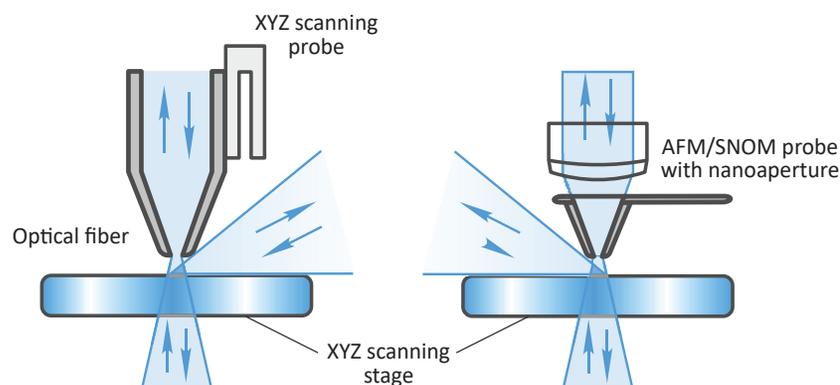


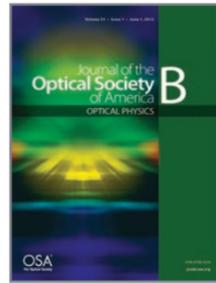
Scanning Near-Field Optical Microscopy



Scanning near-field optical microscopy (SNOM) enables studying a sample's optical properties with resolution far beyond the diffraction limit. Sample fluorescence, light emission, transmission, scattering etc. can be mapped with the spatial resolution down to tens of nanometers.

Two main approaches to the near-field microscopy exist: aperture type SNOM and apertureless techniques.

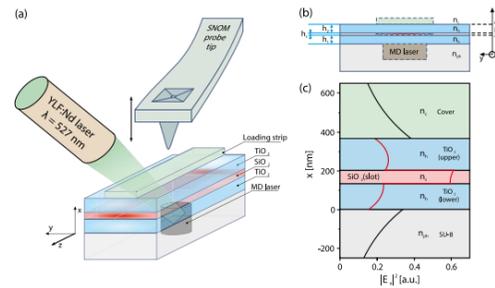
In the first case, a subwavelength size aperture on a scanning tip is used as an optical probe. This is usually an opening in a metal coating of either an optical fiber tip or of a cantilever. Spatial resolution in the aperture type SNOM is, in general, determined by the aperture diameter.



Strip-Loaded Horizontal Slot Waveguide for Routing Microdisk Laser Emission

Marina Fetisova, Natalia Kryzhanovskaya, Igor Reduto, Valentina Zhurikhina, Olga Morozova, Aleksandr Raskhodchikov, Matthieu Roussey, Ségolène Pélisset et al. *Journal of the Optical Society of America B* 37, 1878-1885 (2020) <https://doi.org/10.1364/JOSAB.391993>

A strip-loaded horizontal slot waveguide is used for routing the emission of a microdisk laser. The active region of the laser contains InAs/InGaAs/GaAs quantum dots operating in CW mode under optical pumping. Although the quantum dots emit in a broad range, the laser emission is single mode with $\lambda=1290$ nm. Atomic layer deposition is used for the fabrication of the TiO₂/SiO₂/TiO₂ slot waveguide covering the 10 μ m-diameter disk. The horizontal slot waveguide covers the microdisk and traps the emission in the fundamental TM mode of the three-stack layer. Once light is localized inside this planar waveguide, a loading strip creates an effective index difference, which is sufficient to confine the mode laterally and leads to the guiding of the lasing emission. An analytical model for the five-layer horizontal planar slot waveguide was developed in order to optimize the slot waveguide according to the operation wavelength of the microlaser and the different



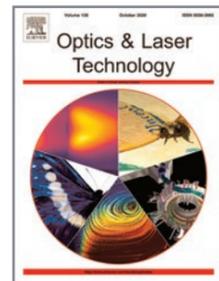
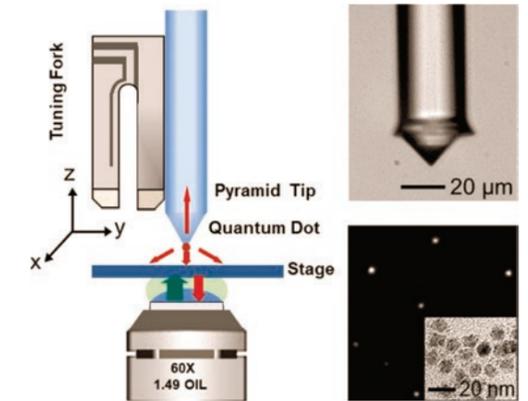
materials involved. Scanning near-field optical microscopy is used to observe the propagation of light within the waveguide and confirm the mode coupling into it and therefore the guiding along the loading strip.



Quantum Dot Decorated Nano-Pyramid Fiber Tip for Scanning Near-Field Optical Microscopy

Pan, B., Yang, Y., Bian, J., Hu, X., & Zhang, W. *Optics Communications*, 2019, 445, 273–276 <https://doi.org/10.1016/j.optcom.2019.04.053>

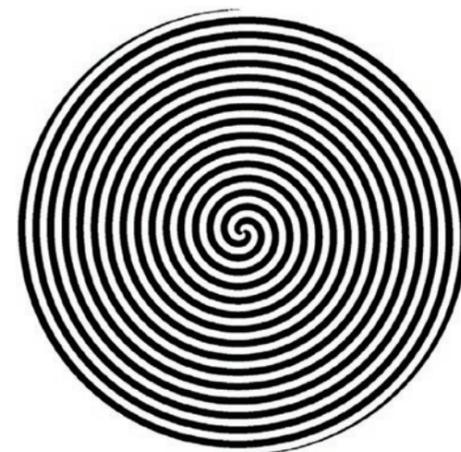
We report a new type of nano-optical tip, the quantum dot decorated nano-pyramid fiber tip, for scanning near-field optical microscopy. The nano-pyramid tip has a large apex angle (70.5 degree), and consequently exhibits a significant improvement (17-fold) of the signal collection efficiency compared to conventional tapered fiber tips. Moreover, thanks to the template-based fabrication method and the surface treatment technique, the quantum-dot decorated nano-pyramid tip enjoys a clean and smooth surface, and can be produced with high accuracy and high reproducibility. Experimental results show that, with the nano-pyramid tip, the optical field distribution of a photonic nanostructure can be mapped with a 20 nm resolution ($\lambda/20$). It provides a powerful and reliable tool for near-field optical measurements.



Two-Petal Laser Beam Near a Binary Spiral Axicon with Topological Charge 2

Kotlyar, V. V., Stafeev, S. S., Nalimov, A. G., Schulz, S., & O’Faolain, L. *Optics and Laser Technology*, 2019, 119, 105649 <https://doi.org/10.1016/j.optlastec.2019.105649>

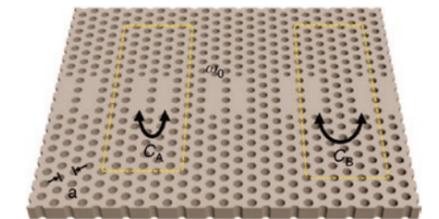
We were the first to notice that although in the immediate vicinity of a spiral axicon with $m > 0$ there is no light ring, there is an intensity pattern composed of several intensity petals, whose number is equal to the axicon topological charge, m . We experimentally demonstrate that a spiral axicon with the topological charge $m = 2$ and numerical aperture $NA \approx 0.6$, operating at a 532 nm wavelength and fabricated by electron lithography, generates a two-petal (TP) laser beam rotating in the near-field (several micrometers away from the microaxicon surface). The rotation rate attained is higher than any that has been reported to date. It is worth noting that the higher the rotation rate of the TP-beam, the higher the axial resolution of an optical system that can be achieved without increasing its NA. Because a small on-axis shift of a point object leads to a large angle of rotation of its TP-image.



Lasing at Topological Edge States in a Photonic Crystal L3 Nanocavity

Han, C., Lee, M., Callard, S., Seassal, C., & Jeon, H. *Light: Science & Applications*, 2019, 8, 40 <https://doi.org/10.1038/s41377-019-0149-7>

Topological photonics have provided new insights for the manipulation of light. Analogous to electrons in topological insulators, photons travelling through the surface of a topological photonic structure or the interface of two photonic structures with different topological phases are free from backscattering caused by structural imperfections or disorder. This exotic nature of the topological edge state (TES) is truly beneficial for nanophotonic devices that suffer from structural irregularities generated during device fabrication. Although various topological states and device concepts have been demonstrated in photonic systems, lasers based on a topological photonic crystal (PhC) cavity array with a wavelength-scale modal volume have not been explored. We investigated TESs in a PhC nanocavity array in the Su–Schrieffer–Heeger model. Upon optical excitation, the topological PhC cavity array realised using an InP-based multiple-



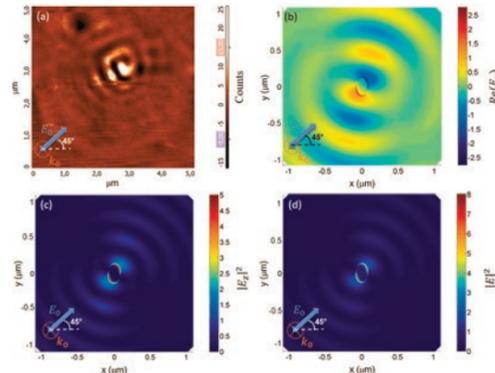
quantum-well epilayer spontaneously exhibits lasing peaks at the topological edge and bulk states. TES characteristics, including the modal robustness caused by immunity to scattering, are confirmed from the emission spectra and near-field imaging and by theoretical simulations and calculations.



Near-Field Imaging of Surface-Plasmon Vortex-Modes around a Single Elliptical Nanohole in a Gold Film

Triolo, C., Savasta, S., Settineri, A., Trusso, S., Saija, R., Agarwal, N. R., & Patanè, S.
Scientific Reports, 2019, 9, 5320
<https://doi.org/10.1038/s41598-019-41781-2>

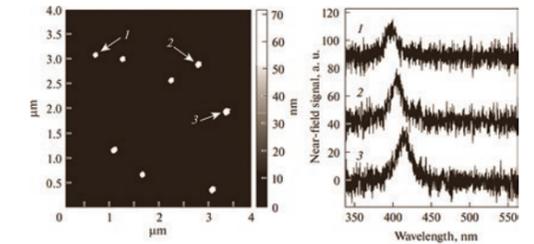
We present scanning near-field images of surface plasmon modes around a single elliptical nanohole in 88 nm thick Au film. We find that rotating surface plasmon vortex modes carrying extrinsic orbital angular momentum can be induced under linearly polarized illumination. The vortex modes are obtained only when the incident polarization direction differs from one of the ellipse axes. Such a direct observation of the vortex modes is possible thanks to the ability of the SNOM technique to obtain information on both the amplitude and the phase of the near-field. The presence of the vortex mode is determined by the rotational symmetry breaking of the system. Finite element method calculations show that such a vorticity originates from the presence of nodal points where the phase of the field is undefined, leading to a circulation of the energy flow. The configuration producing vortex modes corresponds to a nonzero total topological charge (+1).



Scanning Near-Field Optical Nanospectroscopy: a New Method for Nanoscale Measurements of the Absorption Spectra of Single Nanoobjects

Mochalov, K. E., Solovyeva, D. O., Vaskan, I. S., & Nabiev, I. R.
Technical Physics Letters, 2019, 45(2), 138–141
<https://doi.org/10.1134/S1063785019020287>

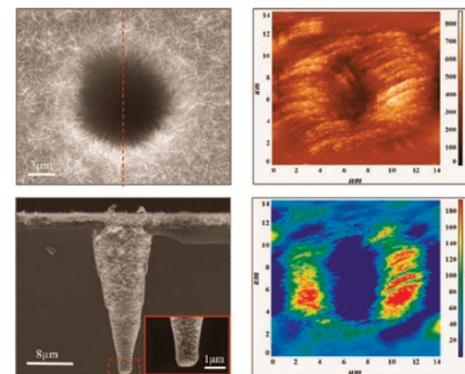
A new experimental method for nanoscale measurements of the absorption spectra of single nanoobjects has been developed based on scanning near-field optical microspectroscopy (SNOM) and nanospectroscopy (NSP). The main distinctive feature of the proposed SNOM-NSP technique consists in depositing a sample onto a coverglass followed by its probing in the total internal reflection spectroscopy mode. This approach allows the number of analyzed samples to be significantly increased and provides the possibility of combining measurements with other optical techniques. The proposed SNOM-NSP method has been successfully used for studying single plasmonic nanoparticles and their complexes with Rhodamine 6G dye.



3D ITO-Nanowire Networks as Transparent Electrode for All-Terrain Substrate

Li, Q., Tian, Z., Zhang, Y., Wang, Z., Li, Y., Ding, W., Wang, T., & Yun, F.
Scientific Reports, 2019, 9, 4983
<https://doi.org/10.1038/s41598-019-41579-2>

A 3D ITO nanowire network with high quality by using polystyrene as an assisted material has been prepared, demonstrating superior optoelectronic performances with a sheet resistance of 193 Ω/sq at 96% transmission. Both remarkable flexibility tested under bending stress and excellent adhesion applied on special terrain substrate have been achieved. This method has led to a full coverage of micro-holes at a depth of 18 μm and a bottom spacing of only 1 μm, as well as a perfect gap-free coverage for micro-tubes and pyramid array. It has been proved that this 3D ITO nanowire network can be used as a transparent conductive layer for optoelectronic devices with any topography surface. Through the application on the micro-holes, -tubes and -pyramid array, some new characteristics of the 3D ITO nanowires in solar cells, sensors, micro-lasers and flexible LEDs have been found. Such 3D ITO nanowire networks could be fabricated directly



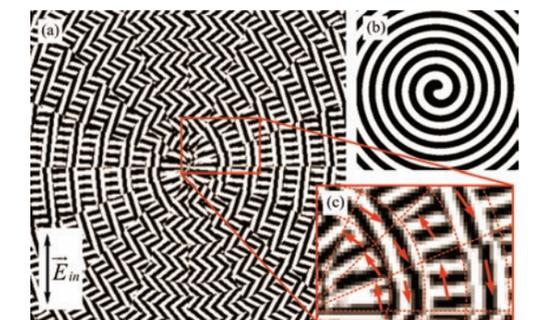
on micro-irregular substrates, which will greatly promote the application of the heterotypic devices.

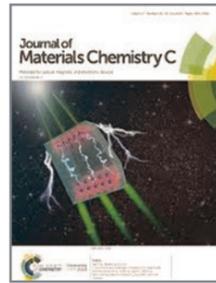


Subwavelength Grating-Based Spiral Metalens for Tight Focusing of Laser Light

Kotlyar, V. V., Stafeev, S. S., Nalimov, A. G., & O'faolain, L.
Applied Physics Letters, 2019, 114(14)
<https://doi.org/10.1063/1.5092760>

In this paper, we investigate a 16-sector spiral metalens fabricated on a thin film (130 nm) of amorphous silicon, consisting of a set of subwavelength binary diffractive gratings and with a numerical aperture that is close to unity. The metalens converts linearly polarized incident light into an azimuthally polarized optical vortex and focuses it at a distance approximately equal to the wavelength of the incident light, $\lambda = 633$ nm. Using a scanning near-field optical microscope, it is shown experimentally that the metalens forms an elliptical focal spot with diameters smaller than the diffraction limit: $\text{FWHM}_x = 0.32\lambda$ ($\pm 0.03\lambda$) and $\text{FWHM}_y = 0.51\lambda$ ($\pm 0.03\lambda$). The experimental results are close to those of a numerical simulation using the FDTD method, with $\text{FWHM}_x = 0.37\lambda$ and $\text{FWHM}_y = 0.49\lambda$. The technological errors due to manufacturing were taken into account in the simulation. This is the smallest focal spot yet obtained with a metalens.

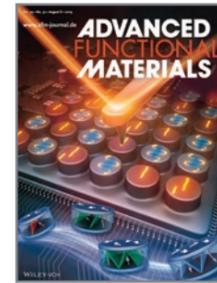
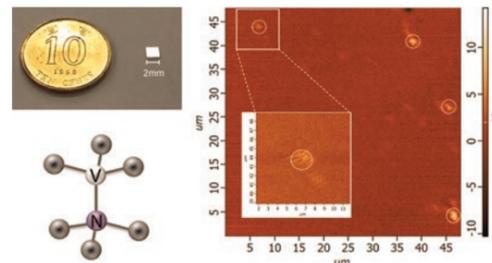




Luminescence Landscapes of Nitrogen-Vacancy Centers in Diamond: Quasi-Localized Vibrational Resonances and Selective Coupling

Su, Z., Ren, Z., Bao, Y., Lao, X., Zhang, J., Zhang, J., Zhu, D., Lu, Y., Hao, Y., & Xu, S. *Journal of Materials Chemistry C*, 2019, 7(26), 8086–8091 <https://doi.org/10.1039/c9tc01954e>

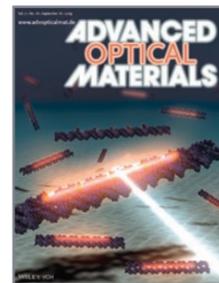
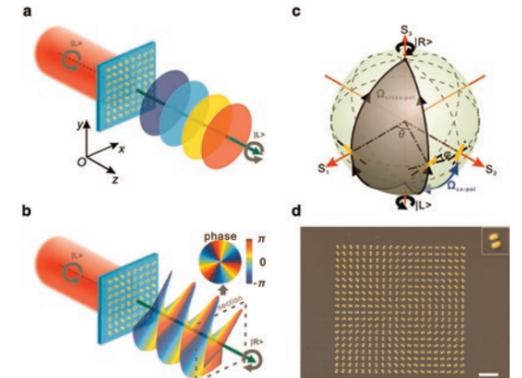
Among the known color centers of diamond, the nitrogen-vacancy (NV) center composed of a substitutional nitrogen and its nearest carbon vacancy could be the most promising photon emitter. In this work, we present the micro-photoluminescence (μ -PL) landscapes of two quasi-localized vibrational resonances (~ 45 and ~ 63 meV) associated with the neutral (NV^0) and negative (NV^-) NV centers, respectively. A symmetric electron-phonon coupling theoretical model was used to simulate the μ -PL spectra with vibronic structures, so that the effective phonon densities of states and Huang-Rhys factors could be obtained for the two charge states of the NV centers. Our study also reveals that the perfect lattice optical phonon mode plays a more significant role in the luminescence of the NV^0 state, whereas the quasi-localized vibrational resonance plays the dominant role in the case of NV^- .



Probing the Photonic Spin-Orbit Interactions in the Near Field of Nanostructures

Lin Sun, Benfeng Bai, Jia Wang, Mingqian Zhang, Xiaomeng Zhang, Xu Song, Lingling Huang *Advanced Functional Materials*, 2019, 29(32), 1902286 <https://doi.org/10.1002/adfm.201902286>

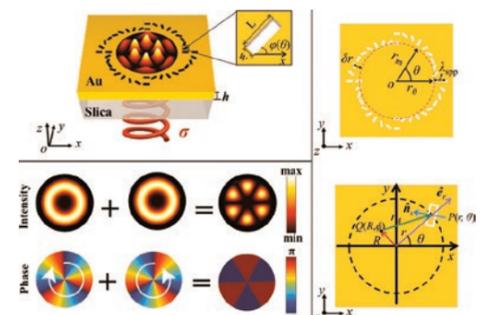
Photonic spin-orbit interactions (SOI) provide a new design paradigm of functional nanomaterials and nanostructures, and have especially accelerated advances in spin-orbit photonics. The Berry phase or the geometric phase, a salient property of SOI, plays a vital role in this process. Thus, the characterization of photonic SOI processes together with the Berry phase is highly demanded for studies such as the optical spin-Hall effect, spin-to-vortex conversion, and Rashba effect. Here, a spin-selective and phase-resolved near-field microscopic method is proposed and experimentally demonstrated for real-time probing and direct visualization of photonic SOI at mesoscale, and a 3D tomographic technique for imaging the spatial evolutions of the optical phases is also properly realized. By analyzing a metallic metasurface as a spin-to-vortex conversion platform, the abrupt geometric phase and the spatially evolutionary dynamic phases are directly measured.



Manipulation for Superposition of Orbital Angular Momentum States in Surface Plasmon Polaritons

Zhang, Y. Q., Zeng, X. Y., Ma, L., Zhang, R. R., Zhan, Z. J., Chen, C., Ren, X. R., He, C. W., Liu, C. X., & Cheng, C. F. *Advanced Optical Materials*, 2019, 7(18), 1–9 <https://doi.org/10.1002/adom.201900372>

Superposition of orbital angular momentum (OAM) states and the structured intensity are providing new approaches for manipulating optical information and light-matter interactions. While superposition of OAMs in free space has been well studied, further extensions to surface plasmon polariton (SPP) confined in near-field would be crucial for miniaturizing and integrating platforms. Here, the plasmonic metasurfaces consisting of rotated nanoslits arranged in a segmented spiral are proposed to realize the superposition of two SPP OAM states. The nanoslit rotation and the azimuthally variant radius of segmented spiral introduce the spin-dependent geometric phase and position-dependent dynamic phase, respectively, and combination of two phases generates two incorporating OAM states. By designing metasurfaces with different parameters, the superposition of two different OAM states and complex structured pattern can be achieved. The four degrees



of freedom including rotation order q , spiral order m , initial orientation angle α_0 , and incident circular polarization σ , enable the superposition of SPP OAM states in a straightforward and flexible manner.

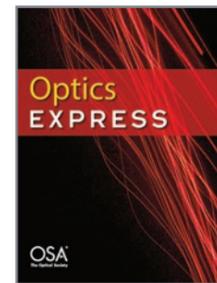
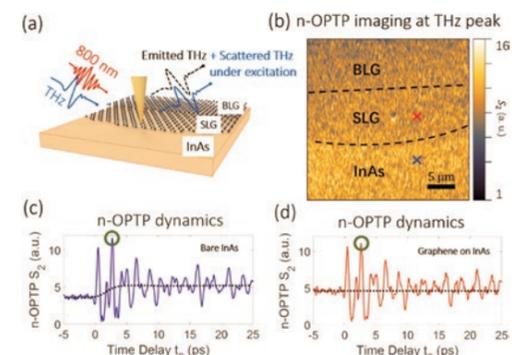
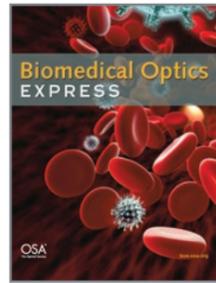


Photo-Induced Terahertz Near-Field Dynamics of Graphene/InAs Heterostructures

Ziheng Yao, Vyacheslav Semenenko, Jiawei Zhang, Scott Mills, Xiaoguang Zhao, Xinzhong Chen, Hai Hu, Ryan Mescall, Thomas Ciavatti, Stephen March, Seth R. Bank, Tiger H. Tao, Xin Zhang, Vasili Perebeinos, Qing Dai, Xu Du, and Mengkun Liu *Optics Express*, 2019, 27(10), 13611-13623 <https://doi.org/10.1364/OE.27.013611>

In this letter, we report optical pump terahertz (THz) near-field probe (n-OPTP) and optical pump THz near-field emission (n-OPTE) experiments of graphene/InAs heterostructures. Near-field imaging contrasts between graphene and InAs using these newly developed techniques as well as spectrally integrated THz nano-imaging (THz s-SNOM) are systematically studied. We demonstrate that in the near-field regime ($\lambda/6000$), a single layer of graphene is transparent to near-IR (800 nm) optical excitation and completely “screens” the photo-induced far-infrared (THz) dynamics in its substrate (InAs). Our work reveals unique frequency-selective ultrafast dynamics probed at the near field. It also provides strong evidence that n-OPTE nanoscopy yields contrast that distinguishes single-layer graphene from its substrate.

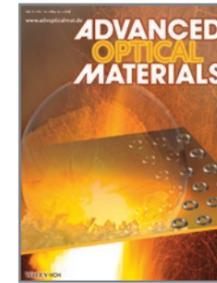
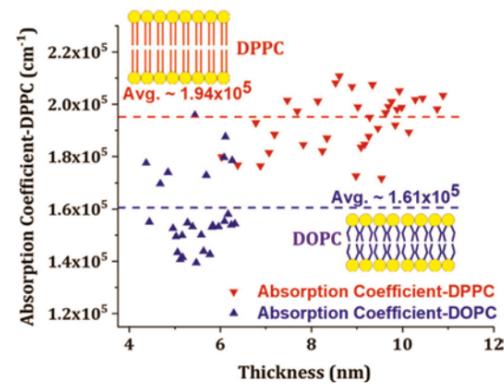




Visualization and Measurement of the Local Absorption Coefficients of Single Bilayer Phospholipid Membranes Using Scanning Near-Field Optical Microscopy

Siddiquee, A. M., Hasan, I. Y., Wei, S., Langley, D., Balaur, E., Liu, C., Lin, J., Abbey, B., Mechler, A., & Kou, S.
Biomedical Optics Express, 2019, 10,(12), 6569
<https://doi.org/10.1364/boe.10.006569>

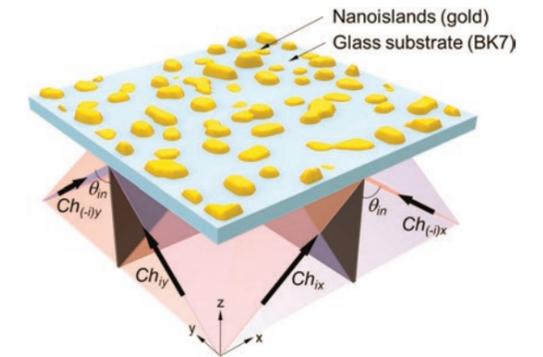
Here we report the results of shear-mode thicknesses and absorption coefficient measurements made on neat membranes using scanning near-field optical microscopy (SNOM). Biomimic neat membranes composed of two different types of phospholipid molecules: 1,2-dioleoyl-sn-glycero-3-phosphocholine (DOPC) and 1,2-dipalmitoyl-sn-glycero-3-phosphocholine (DPPC) were found to exhibit different absorption coefficients under the SNOM. The localization of the lipids could be identified and correlated to the morphology of the membrane domains indicating that SNOM can be an effective and accurate approach for the label-free characterization of the structure-function relationships in cell membranes.



Metallic 3D Random Nanocomposite Islands For Near-Field Spatial Light Switching

Son, T., Moon, G., Lee, H. & Kim, D.
Advanced Optical Materials, 2018, 6(10), 1701219
<https://doi.org/10.1002/adom.201701219>

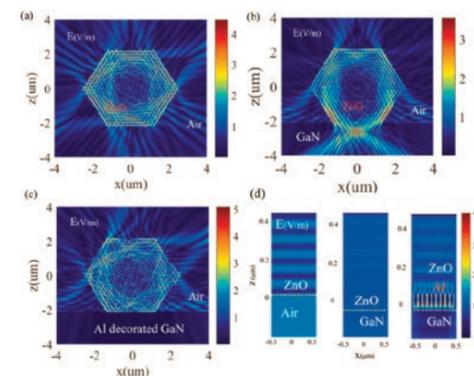
Random nanocomposite islands have drawn significant interest for diverse applications due to extreme simplicity of fabricating nanoscale structures. In this paper, the near-field characteristics of random nanocomposite islands produced by spatial light switching are investigated, with light incidence switching among 14 incident channel modes. The results show that localized light fields are displaced from nanocomposite islands almost linearly with the incident angle of channels. Also, light fields rotate in a manner aligned to the direction of light incidence. Ten-channel spatial switching is found to provide coverage of near-fields on the surface close to 90%. The numerical data are experimentally validated using fluorescent imaging and near-field scanning optical microscopy. The results suggest the possibility of using random nanocomposite islands for high performance imaging such as superresolution microscopy and molecular detection techniques.



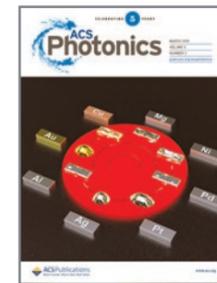
Interfacial Control of ZnO Microrod for Whispering Gallery Mode Lasing

Fiefei Qin, Chunxiang Xu, Dang Yuan Lei, Siqi Li, Jin Liu, Qiuxiang Zhu, Qiannan Cui, Daotong You, A. Gowri Manohari, Zhu Zhu, and Feng Chen
ACS Photonics 2018, 5, 6, 2313–2319
<https://doi.org/10.1021/acsp Photonics.8b00128>

Energy loss control at interfacial areas is a significant issue to improve the optical performance of hybrid optical resonant cavities. In this work, we analyzed the simulated electric field intensity to predict the optical loss or gain in ZnO microrod cavity interfaced with both pristine and Al nanoparticles decorated GaN gratings. A single ZnO microrod was placed on GaN gratings to compose three interfacial configurations, these are, ZnO/Air, ZnO/GaN, and ZnO/Al/GaN, their lasing behaviors were investigated experimentally. Experimental results indicate that the lasing intensity, threshold power, and quality factor all depend on interfacial gain and loss. Through introducing the localized surface plasmon resonance (LSPR) of Al nanoparticles at interface areas, improved lasing performance was observed for the ZnO/Al/GaN hybrid structure. Furthermore, the LSPR coupling mechanism responsible for the observed lasing improvement was revealed by the scanning



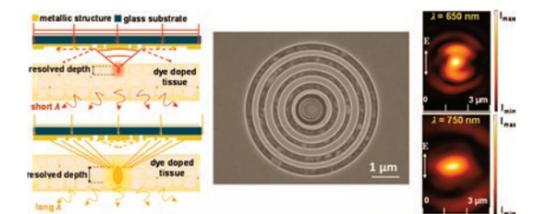
near-field optical microscopy (SNOM) and time-resolved photoluminescence (TRPL) spectroscopy.



Three-Dimensional Resolvable Plasmonic Concentric Compound Lens: Approaching the Axial Resolution from Microscale to Nanoscale

Chang, K., Chen, Y., Chang, W. & Lee, P.
ACS Photonics 2018, 5, 3, 834–843
<https://doi.org/10.1021/acsp Photonics.7b01003>

We propose the design and working principle of a plasmonic concentric compound lens (CCL) comprising inner circular nanoslits and outer circular nanogrooves. Dual-wavelength operations have been achieved for 650 and 750 nm at nanoscale and microscale focal lengths along with their depth of focus (DOF). By tuning the arrangement of nanogrooves, the axial resolution can be modulated and the narrowest DOF is achieved by a design of gradually decreasing groove width. For the ultrahigh tunability of axial resolution, DOF over 400 nm for both working wavelengths is also achieved. We not only developed an approximate-perturbed-focus model for explaining the performance of DOF but also found an extraordinary way to improve the resolution. The enhanced resonance of central disk as nanoantenna in CCL also has great influence on nanofocusing with different designs of outer nanogrooves. This work provides new sight of focusing ability governed by



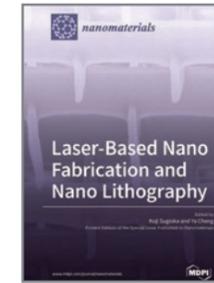
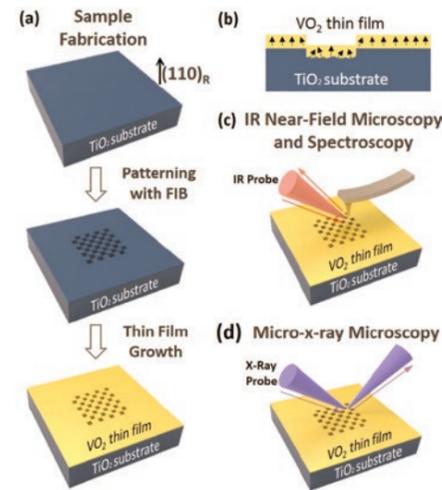
the general optical nanogrooves. The optimized CCL shows excellent focusing performance with a lateral resolution down to 0.32λ ($\lambda=650$ nm), which is the best resolving ability achieved thus far in the near field region with a long focal length up to 500 nm.



Controlling Phase Separation in Vanadium Dioxide Thin Films via Substrate Engineering

Corder, S. N. G. et al.
 Phys. Rev. B. 2017, 96, 161110
<https://doi.org/10.1103/PhysRevB.96.161110>

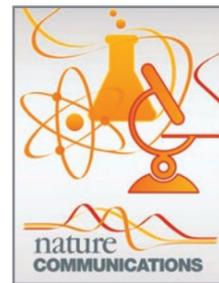
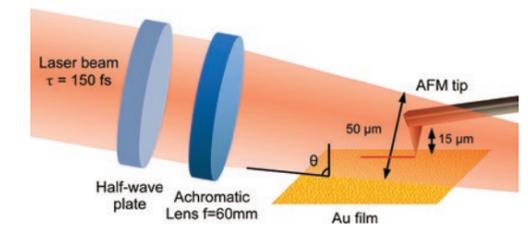
The strong electron-lattice interactions in correlated electron systems provide unique opportunities for altering the material properties with relative ease and flexibility. In this Rapid Communication, we use localized strain control via a focused-ion-beam patterning of TiO₂ substrates to demonstrate that one can selectively engineer the insulator-to-metal transition temperature, the fractional component of the insulating and metallic phases, and the degree of optical anisotropy down to the length scales of the intrinsic phase separation in VO₂ thin films without altering the quality of the films. The effects of localized strain control on the strongly correlated electron system are directly visualized by state-of-the-art IR near-field imaging and spectroscopy techniques and x-ray microdiffraction measurements.



Subwavelength Nanostructuring of Gold Films by Apertureless Scanning Probe Lithography Assisted by a Femtosecond Fiber Laser Oscillator

Ignacio Falcón Casas, and Wolfgang Kautek
 Nanomaterials 2018, 8(7), 536
<https://doi.org/10.3390/nano8070536>

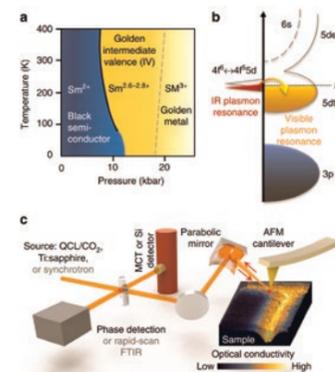
Optical methods in nanolithography have been traditionally limited by Abbe's diffraction limit. One method able to overcome this barrier is apertureless scanning probe lithography assisted by laser. This technique has demonstrated surface nanostructuring below the diffraction limit. In this study, we demonstrate how a femtosecond Yb-doped fiber laser oscillator running at high repetition rate of 46 MHz and a pulse duration of 150 fs can serve as the laser source for near-field nanolithography. Subwavelength features were generated on the surface of gold films down to a linewidth of 10 nm. The near-field enhancement in this apertureless scanning probe lithography setup could be determined experimentally for the first time. Simulations were in good agreement with the experiments. This result supports near-field tip-enhancement as the major physical mechanisms responsible for the nanostructuring.



Near-Field Spectroscopic Investigation of Dual-Band Heavy Fermion Metamaterials

Corder, S. N. G. et al.
 Nat Commun 8, 2262 (2017)
<https://doi.org/10.1038/s41467-017-02378-3>

Broadband tunability is a central theme in contemporary nanophotonics and metamaterials research. Combining metamaterials with phase change media offers a promising approach to achieve such tunability, which requires a comprehensive investigation of the electromagnetic responses of novel materials at subwavelength scales. In this work, we demonstrate an innovative way to tailor band-selective electromagnetic responses at the surface of a heavy fermion compound, samarium sulfide (SmS). By utilizing the intrinsic, pressure sensitive, and multi-band electron responses of SmS, we create a proof-of-principle heavy fermion metamaterial, which is fabricated and characterized using scanning near-field microscopes with <50 nm spatial resolution. The optical responses at the infrared and visible frequency ranges can be selectively and separately tuned via modifying the occupation of the 4f and 5d band electrons. The unique pressure, doping,



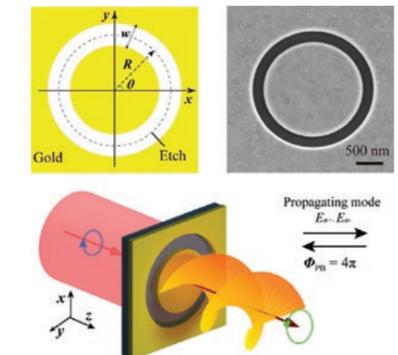
and temperature tunability demonstrated represents a paradigm shift for nanoscale metamaterial and metasurface design.



Spin-Symmetry-Selective Generation of Ultracompact Optical Vortices in Nanoapertures without Chirality

Tong Cui, Mingqian Zhang, Lin Sun, Shuyin Zhang, Jia Wang, Benfeng Bai, and Hong-Bo Sun
 Small Struct. 2020, 2000008
<https://doi.org/10.1002/ssstr.202000008>

Nanoscale optical vortices (OVs) carrying orbital angular momenta can be generated via photonic spin-orbit interaction (SOI) in nanostructures and have important applications in many emerging fields such as quantum communication and optical manipulations. Existing OV generators such as metasurfaces and chiral structures suffer from discontinuous wavefront modulation, single-spin response, and bulk size. The photonic SOI in highly symmetric structures has been overlooked. Here, by studying the SOI in a plasmonic annular nanoaperture, a simple and reliable way for generating ultracompact OVs and OV array in nanoapertures without chirality is reported. The generation of a 3×3 OV array within a small area of 6×6 μm² is demonstrated experimentally. Using a homemade spin-selective and phase-resolved near-field microscopic system, in the spin basis, the dynamic evolution of the wavefront of the generated OV is



directly probed from the near-field to the far-field with subwavelength resolution, which intuitively reveals the SOI process.

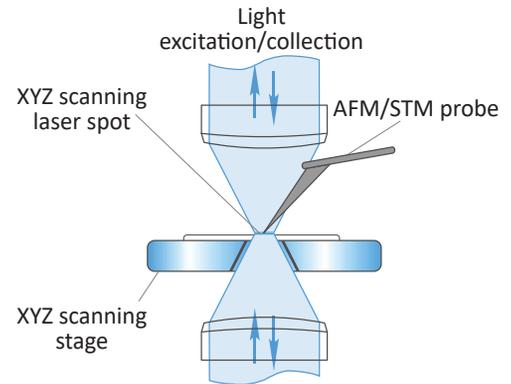
Scanning Near-Field Optical Microscopy

Scientific Digest

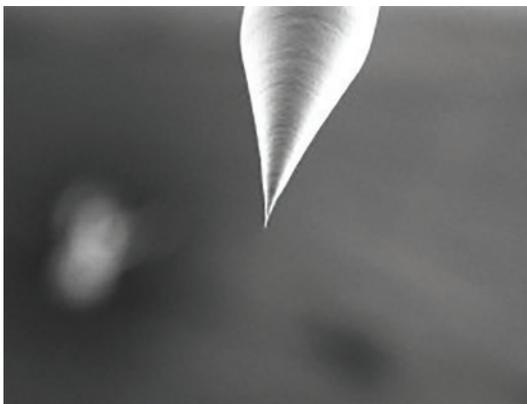
Useful Features

Optical Access

Novel optical scheme consists of up to three independent channels for sample excitation and signal collection: from top, side and bottom directions. Each optical channel is an independent module and combines with other channels in any configuration. When system is assembled, excitation/collection directions are easily exchanged between each other during less than a minute. Open design provides great opportunities in system customization. Every particular channel allows to observe the sample by the objective with magnification factor up to 100x, excite the sample by laser light and scan by focused laser spot, which is especially important for finding "hot spot" in TERS measurements.



<https://www.ntmdt-si.com/products/afm-raman-nano-ir-systems/ntegra-spectra-ii>



SNOM Fiber Probes

Fiber probes with the formed aperture on the very tip apex are specially designed for Scanning Near-Field Optical Microscopy. They are prepared by chemical etching method.

This method gives the optical efficiency $10^2 - 10^4$ times better than those obtained by mechanical pulling. Probe tip is coated by Al (70 nm) and sublayer V (20 nm). Tip diameter uncoated by Al (tip aperture) is 50-90 nm (70 ± 20).

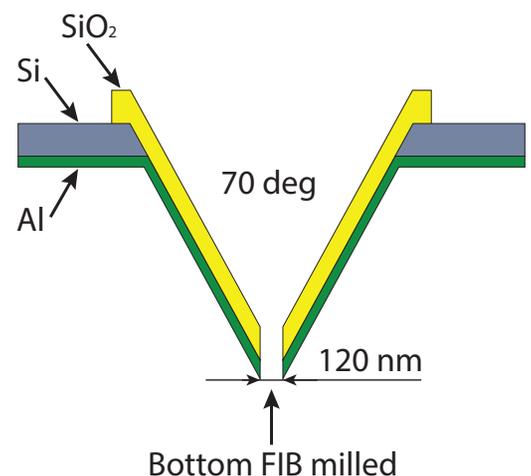
Angle of fiber is about 20 degrees. These parameters are a compromise between high resolution and high transmission. The maximum optical input power - 0.4 mW.

<http://www.ntmdt-tips.com/products/view/mf001>

SNOM Cantilever Probes

Cantilever based SNOM probe are designed to operate in AFM semicontact or contact modes. AFM feedback mechanism allow to prevent significant damage of the tip or sample while scanning process. Probes have Al coating from bottom side of about 100 nm. Bottom FIB milling should be done after coating. Typical aperture diameter is about $120 \text{ nm} \pm 25 \text{ nm}$.

Thanks to the robust materials and high angle at the apex it is possible to couple $\sim 10 \text{ mW}$ laser power which improves near-field signal a lot. Another important issue is that cantilever probe doesn't disturb polarization of the light which could be important in photonic spin-orbit interactions studies.



<http://www.ntmdt-tips.com/products/group/snom-cantilevers-new>