

**The 20th international Conference on Photorefractive
Photonics and Beyond – Interaction of Light with Matter
(PR'26)**

Book of Abstracts

August 14 – 18, 2026

Xi'an Guangcheng Hotel, Xi'an, China

Organized by

Nankai University

Northwestern Polytechnical University

co-organized by

Xi'an Laser and Infrared Society

WELCOME TO PR'26

Dear PR'26 Attendees

The International Conference on Photorefractive Photonics and Beyond was inaugurated in Los Angeles in 1987 and has since been held biennially. The upcoming 20th edition, PR'26, will take place from August 14 to 18, 2026, in Xi'an, Shaanxi Province, China. The conference is hosted by Nankai University and Northwestern Polytechnical University, and co-organized by the Xi'an Laser and Infrared Society.

Building on the strong legacy of previous meetings, PR'26 aims to promote exchange across a wide range of research fields that share foundational physics, core light-matter interaction phenomena, as well as common fabrication strategies and applications. By encouraging cross-disciplinary dialogue, we hope to spark new ideas and inspire innovative approaches to harnessing light-driven processes—the very mechanisms that, at their fundamental level, give rise to photorefractivity.

We look forward to welcoming you to Xi'an and wish you a wonderful and productive time at PR'26!

Warmest regards,

Organizing Committee

Prof. Jingjun Xu (Nankai University)

Prof. Jianlin Zhao (Northwestern Polytechnical University)



Jingjun Xu



Jianlin Zhao

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Schedule

Day 0: Friday, August 14	
All Day	Conference Registration (Hotel Lobby, 1F)
18:30–20:30	Self-Service Buffet Dinner (1F Self-Service Restaurant)
Venue	Xi'an Guangcheng Hotel
Friendly Reminders	
Invited/Oral Presentations	■ Invited presentation: 30 minutes, oral presentation: 15 minutes, both including Q&A time. After the presentation, questions and answers may be arranged as appropriate, and a brief comment may be given. ■ Presenters are requested to copy their PPT files to the meeting computer in advance. If you have special requirements such as using your own laptop for presentation, please inform the volunteer at the session in advance.
Poster Presentations	Evaluation rules: ■ The poster exchange session will be held from 16:00 to 17:30 on August 15. Please complete your poster mounting before 13:30 on August 15. ■ The poster should present novel content with originality and high scientific quality. ■ The content should be clearly stated, logically analyzed, with solid and reliable results and sufficient supporting evidence.
Meals	◆ August 14: Dinner will be provided. ■ August 15–17: Both lunch and dinner will be provided. ■ Please present your meal voucher at the designated dining location. All meal vouchers will be distributed together with your conference badge upon registration. Please keep them safe; lost vouchers will not be replaced. For any questions, please inquire at the registration desk on the ground floor.
Hotel	For participants staying at Xi'an Guangcheng Hotel (Middle Section, Laodong South Road, Lianhu District, Xi'an), please note that check-out time is before 2:00 p.m. If you need to extend your stay, please contact the conference organizing committee as early as possible so that we can coordinate with the hotel in advance.
Contact Information of the Organizing Committee	Invoice inquiries: Yuexia Ning, 13661950683 Registration inquiries: Fanfan Lu, 18571357846

Day 1: Saturday, August 15		Venue: 3F International Ballroom
Opening Ceremony		
Host: Prof. Guoquan Zhang, Nankai University		
08:30 – 08:50	Opening Remarks Speakers Prof. Jingjun Xu Nankai University, Conference Chair Prof. Jianlin Zhao Northwestern Polytechnical University, Conference Chair	
Session 1.1		
Session Theme: Broadband Nonlinear Lasers & LNOI Thin Film Devices		
Host: Prof. Jiafang Li, Beijing Institute of Technology		
08:50–09:20	Title: Nonlinear up-conversion/down-conversion synergy enabling intense DUV-Vis-FIR full-spectrum white laser generation Prof. Zhiyuan Li (Invited) South China University of Technology	
09:20–09:50	Title: Thin-film Lithium Niobate for Mode-Phase-Matching Based Nonlinear Photonics Prof. Feng Chen (Invited) Shandong University	
09:50–10:00	Group Photo Venue: 3F International Ballroom	
10:00–10:30	Coffee Break Venue: 3F International Ballroom	
Session 1.2		
Session Theme: Ferroelectric Domain Modulation & Low-Dimensional Exciton Photonics		
Host: Prof. Dong Mao, Northwestern Polytechnical University		
10:30–11:00	Title: Ferroelectric domain engineering Prof. Hao Tian (Invited) Harbin Institute of Technology	
11:00–11:30	Title: Optical Control of Woven Ferroelectric Domains Assoc. Prof. Feifei Xin (Invited) Nankai University	
11:30–12:00	Title: Exciton Behaviors in van der Waals Materials: Modulation and Optoelectronic Applications Prof. Xiaoxian Zhang (Invited) Beijing Jiaotong University	
12:00–13:30	Self-Service Buffet Lunch Venue: 1F Self-Service Restaurant	

Session 1.3 Session Theme: Ultrafast Fiber Lasers & Reconfigurable Metasurface Devices Host: Prof. Hao Tian, Harbin Institute of Technology	
14:00–14:30	Title: Multi-dimensional modulation of ultrafast fiber lasers Prof. Dong Mao (Invited) Northwestern Polytechnical University
14:30–15:00	Title: Electromechanically programmable optical metasurfaces for dynamic light-field manipulation Prof. Jiafang Li (Invited) Beijing Institute of Technology
15:00–15:15	Title: All-Optical Reconfigurable Second-Harmonic Generation in MoS ₂ Prof. Yi Zhang (Oral) Northwestern Polytechnical University
15:15–15:30	Title: Tunable OAM interaction between phase and intensity singularities Prof. Yi Liang (Oral) Guangxi University
15:30–16:00	Coffee Break Venue: 3F International Ballroom
Session 1.4 Session Theme: Poster Session Venue: 3F International Ballroom Host: Prof. Xinzheng Zhang, Nankai University	
16:00–17:30	All poster authors are available for academic communication: 1. Ru Zhao, Master student, Hebei University 2. Qian Liu, PhD student, Guangxi University 3. Nicolas Marsal, Professor, Université de Lorraine 4. Nicolas Marsal, Professor, Université de Lorraine 5. Ruoqi Chen, PhD student, Nankai University 6. Binwen Niu, PhD student, Nankai University 7. Rui Yang, PhD student, Nankai University 8. Xiaolong Wang, PhD student, Nankai University 9. Shengbo Song, PhD student, Nankai University 10. Biao Dong, PhD student, Nankai University 11. Xudong Tong, PhD student, Nankai University 12. Yueweiying Wang, PhD student, Northwestern Polytechnical University 13. Xu Ji, PhD student, Northwestern Polytechnical University
18:30–20:30	Conference Banquet Dinner/Excellent Poster Award Ceremony Venue: 2F No.1 Meeting Room

Day 2: Sunday, August 16		Venue: 3F International Ballroom	
Session 2.1			
Session Theme: Integrated Lithium Niobate Chips & Photorefractive Microresonators			
Host: Prof. Dehui Sun, University of Jinan			
08:30–09:00	Title: Lithium Niobate Photonic Integrated Circuits Prof. Ya Cheng (Invited) East China Normal University		
09:00–09:30	Title: Activation and suppression of photorefractive effects in LiNbO ₃ microresonators for Kerr frequency comb generation and stabilization Prof. Qifan Yang (Invited) Peking University		
09:30–09:45	Title: Enhanced Photorefractive Response Speed in W- and Zr, W-Doped LiNbO ₃ Crystals in the Visible Band Prof. Tian Tian (Oral) Shanghai Institute of Technology		
09:45–10:00	Title: Progress in Lithium Niobate-Based Photovoltaic Manipulation Technology for Fluids and Solids Prof. Wenbo Yan (Oral) Hebei University of Technology		
10:00–10:30	Coffee Break Venue: 3F International Ballroom		
Session 2.2			
Session Theme: Lithium Niobate Thin Films & Crystal Growth Technology			
Host: Prof. Qifan Yang, Peking University			
10:30–11:00	Title: Lithium niobate thin films: Recent advances and photonic applications Prof. Hui Hu (Invited) Shandong University		
11:00–11:30	Title: Lithium Niobate Crystal Growth and Optical Quality Evaluation Prof. Dehui Sun (Invited) University of Jinan		
11:30–11:45	Title: On-Chip Nonlinear Optical Physical Unclonable Function Based on Thin-Film Lithium Niobate Array Assoc. Prof. Pengfa Chang (Oral) Taiyuan University of Technology		
11:45–12:00	Title: Efficient self-amplification in monolithically integrated laser on Er/Yb co-doped lithium niobate on insulator Lecturer Yuyi Zhang (Oral) Nankai University		
12:00–13:30	Self-Service Buffet Lunch Venue: 1F Self-Service Restaurant		

Session 2.3 Session Theme: Photorefractive Nonlinear Dynamics & 3D Laser Fabrication Host: Prof. Lung-Han Peng, National Taiwan University	
14:00–14:30	Title: Structured Light: Tailoring Optical Fields Towards Nonlinear Dynamics Prof. Nicolas Marsal (Invited) Université de Lorraine, CentraleSupélec, France
14:30–15:00	Title: High-Efficiency 3D Nonlinear Photonic Crystals Based on Laser Direct Writing Prof. Yan Sheng/Dr. Shan Liu (Invited) Ningbo University/Australian National University, Australia
15:00–15:15	Title: Fiber Bragg gratings inscribed in ring core fiber by femtosecond laser Prof. Yajun Jiang (Oral) Northwestern Polytechnical University
15:15–15:30	Title: Ultra-compact wavelength- and mode-division (de)multiplexers on 4H-silicon-carbide-on-insulator platform via inverse design Dr. Wenjie Zhang (Oral) Nankai University
15:30–16:00	Coffee Break Venue: 3F International Ballroom
Session 2.4 Session Theme: Liquid Crystal Tunable Metasurfaces & Vortex Photonics Host: Prof. Nicolas Marsal, Université de Lorraine, CentraleSupélec, France	
16:00–16:30	Title: Dye-Doped Liquid Crystal Mediated All-Optical Tuning of Dielectric Metasurfaces Prof. Andrey Iljin (Invited) The Max Planck Institute for the Science of Light, Germany
16:30–17:00	Title: Nonlinear Coupling and Mode Conversion for Vortex Beam Generation in Waveguiding Nonlinear Photonic Crystals Prof. Lung-Han Peng (Invited) National Taiwan University
17:00–17:30	Title: Boosting and steering excitonic emission with a plasmonic nanocavity Prof. Fajun Xiao (Invited) Northwestern Polytechnical University
17:30–17:45	Title: Plasmonic Fiber Tip-Enhanced Nanospectroscopy Assoc. Prof. Fanfan Lu (Oral) Northwestern Polytechnical University
18:30–20:30	Self-Service Buffet Dinner Venue: 1F Self-Service Restaurant

Day 3: Monday, August 17		Venue: 3F International Ballroom
Session 3.1 Session Theme: On-Chip Photonics & Ferroelectric Liquid Crystal Photonics Host: Prof. Ligang Huang, Chongqing University		
08:30–09:00	Title: Observation of Goos-Hanchen Shift under Normal Incidence in Slanted TiO ₂ Nanogratings Prof. Yuancheng Fan (Invited) Northwestern Polytechnical University	
09:00–09:30	Title: Group-velocity engineering and topological light stopping in photonic lattices through long-range couplings Prof. Xinyuan Qi (Invited) Northwest University	
09:30–09:45	Title: Light–Matter Interactions in Ferroelectric Nematics: From Bulk Photovoltaics to Photorefractive Gratings Dr. Hasson Faheem (Oral) Nankai University	
09:45–10:00	Title: Nematic Ferroelectric Liquid Crystals: Bridging the Fundamental Gap Between Solid and Liquid Ferroelectrics through Polar Order in Fluids Dr. Lotfi SAADAoui (Oral) Nankai University	
10:00–10:30	Coffee Break Venue: 3F International Ballroom	
Session 3.2 Session Theme: On-Chip Photonics & Conference Closing Summary Host: Prof. Xinyuan Qi, Northwest University		
10:30–11:00	Title: Metasurface-Based Near- and Far-Field Vector Holography Prof. Dandan Wen (Invited) Northwestern Polytechnical University	
11:00–11:15	Title: On-Chip Acousto-Optic Superlattice Modulation Based on Surface Acoustic Wave and Micro-Nano Optical Waveguide Prof. Ligang Huang (Oral) Chongqing University	
11:15–11:30	Title: Ghost imaging with zero photons Assoc. Prof. Jianbin Liu (Oral) Xi'an Jiaotong University	
11:30–11:45	Title: Characterize localization length of disordered lattices via critical coupling effect Prof. Peilong Hong (Oral) Anqing Normal University	
11:45–12:00	Title: Width-reshaped photonic-crystal ring resonators for localized dispersion engineering Assoc. Prof. Zhenzhong Hao (Oral) Nankai University	

12:00–13:30	Self-Service Buffet Lunch Venue: 1F Self-Service Restaurant
14:00–16:00	Organizing Committee Internal Meeting Venue: 2F No.2 Meeting Room Participants: Organizing Committee Members
16:00–16:15	Closing Remarks Speakers: Prof. Jingjun Xu, Prof. Jianlin Zhao (Conference Co-Chairs)
18:30–20:30	Self-Service Buffet Dinner Venue: 1F Self-Service Restaurant

Day 4: Tuesday, August 18

Morning

Laboratory Tours & Conference Departure

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- [1] Dynamic visualization of the photorefractive effect via single-pixel complex-amplitude imaging. **Ru Zhao, Hebei University**
- [2] Interplay of Flat-band and Anderson localizations in disordered moiré superlattices. **Qian Liu, Guangxi University**
- [3] Virtual-Depth Photonic Reservoir Computing for High-Speed Neuromorphic Signal Processing. **Nicolas Marsal, Université de Lorraine**
- [4] Fibonacci and Degenerate Conical Diffraction Cascades for Advanced Vector Beam Engineering. **Nicolas Marsal, Université de Lorraine**
- [5] Sub-symmetry-protected compact edge states. **Ruoqi Chen, Nankai University**
- [6] A Monolithic Active-Passive LNOI Photonic Integration Platform via Localized Thermal Diffusion. **Binwen Niu, Nankai University**
- [7] Temperature-Dependent Conductivity at Head-to-Head and Tail-to-Tail Domain Walls in Lithium Niobate Thin Films. **Rui Yang, Nankai University**
- [8] Compact Broadband Polarization-Insensitive Edge Coupler on SiCOI Based on Multi-Tip Subwavelength Gratings and Inverse Design. **Xiaolong Wang, Nankai University**
- [9] Direct writing of nanoscale periodic domain structures in lithium niobate thin films on silicon substrates. **Shengbo Song, Nankai University**
- [10] Probing High-Temperature Sliding Ferroelectricity via Nonlinear Optical Spectroscopy. **Biao Dong, Nankai University**
- [11] A Compact Broadband Inverse-Designed Polarization Rotator on a 4H-SiC-on-Insulator Platform. **Xudong Tong, Nankai University**
- [12] Carrier-Dynamics-Mediated Ultrafast Control of Terahertz Harmonic Generation in Nonlinear Metasurfaces. **Yueweiying Wang, Northwestern Polytechnical University**
- [13] Vectorial Light Field for Raman Spectroscopy, Quantum Coupling, and DNA Decoding. **Xu Ji, Northwestern Polytechnical University**

List of Participants

Participants	Institution	Country	Contribution
Bo, Fang	Nankai University	China	Participation
Cao, Dawei	Shandong University	China	Participation
Chang, Pengfa	Taiyuan University of Technology	China	Oral 2.2
Chen, Feng	Shandong University	China	Invited 1.1
Chen, Ruoqi	Nankai University	China	Poster No.5
Cheng, Ya	East China Normal University	China	Invited 2.1
Dong, Biao	Nankai University	China	Poster 10
Faheem, Hasson	Nankai University	China	Oral 3.1
Fan, Yuancheng	Northwestern Polytechnical University	China	Invited 3.1
Hao, Zhenzhong	Nankai University	China	Oral 3.2
Hong, Peilong	Anqing Normal University	China	Oral 3.2
Hu, Hui	Shandong University	China	Invited 2.2
Huang, Ligang	Chongqing University	China	Oral 3.1
Iljin, Andrey	The Max Planck Institute for the Science of Light, Erlangen	Germany	Invited 2.4
Ji, Xu	Northwestern Polytechnical University	China	Poster 14
Jiang, Yajun	Northwestern Polytechnical University	China	Oral 2.3
Kong, Yonfa	Nankai University	China	Participation
Li, Jiafang	Beijing Institute of Technology	China	Invited 1.3
Li, Zhiyuan	South China University of Technology	China	Invited 1.1
Liang, Yi	Guangxi University	China	Oral 1.3
Liu, Jianbin	Xi'an Jiaotong University	China	Oral 3.2
Liu, Qian	Guangxi University	China	Poster 2
Liu, Shan	Australian National University	Australia	Invited 2.3
Lu, Fanfan	Northwestern Polytechnical University	China	Oral 2.4
Mao, Dong	Northwestern Polytechnical University	China	Invited 1.3
Marsal, Nicolas	Université de Lorraine CentraleSupélec	France	Invited 2.3; Poster 3, 4
Niu, Binwen	Nankai University	China	Poster 6
Peng, Lung-Han	Natl Taiwan Univ	China	Invited 2.4
Qi, Xinyuan	Northwest University	China	Oral 3.2
Saadaoui, Lotfi	Nankai University	China	Oral 3.1
Song, Limin	Nankai University	China	Participation
Song, Shengbo	Nankai University	China	Poster 9
Sun, Dan	Northwestern University	China	Participation
Sun, Dehui	University of Jinan	China	Invited 2.2
Tang, Liqin	Nankai University	China	Participation
Tao, Can	Nankai University	China	Participation
Tian, Hao	Harbin Institute of Technology	China	Invited 1.2

Tian, Tian	Shanghai Institute of Technology	China	Oral 2.1
Tong, Xudong	Nankai University	China	Poster 11
Wang, Xiaolong	Nankai University	China	Poster 8
Wang, Yueweiying	Northwestern Polytechnical University	China	Poster 13
Wang, Yongsheng	Beijing Jiaotong University	China	Participation
Wen, Dandan	Northwestern Polytechnical University	China	Invited 3.2
Xiao, Zongliang	Jiangxi University of Science and Technology	China	Participation
Xin, Feifei	Nankai University	China	Invited 1.2
Xu, Jingjun	Nankai University	China	Chair
Yan, Wenbo	Hebei University of Technology	China	Oral 2.1
Yang, Qifan	Peking University	China	Invited 2.1
Yang, Rui	Nankai University	China	Poster 7
Ye, Zhehao	Northwestern Polytechnical University	China	Poster 12
Zhang, Dong	Shanghai Institute of Technology	China	Participation
Zhang, Guoquan	Nankai University	China	Participation
Zhang, Xiaoxian	Beijing Jiaotong University	China	Invited 1.2
Zhang, Xinzheng	Nankai University	China	Participation
Zhang, Yi	Northwestern Polytechnical University	China	Oral 1.3
Zhang, Yuyi	Nankai University	China	Oral 2.2
Zhang, Wenjie	Nankai University	China	Oral 2.3
Zhao, Jianlin	Northwestern Polytechnical University	China	Chair
Zhao, Ru	Hebei University	China	Poster 1
Zhu, Junda	Tianjin Normal University	China	Participation

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Thin-film Lithium Niobate for Mode-Phase-Matching Based Nonlinear Photonics

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Thin-film lithium niobate (TFLN) represents a highly promising platform for integrated nonlinear optics and photonics, owing to its strong optical confinement and large nonlinear coefficients. We employ the double-layer lithium niobate nonlinear waveguide based on mode phase matching (MPM). This approach fundamentally eliminates the need for periodic poling—a requisite step in conventional quasi-phase matching (QPM) schemes—thereby simplifying fabrication and reducing optical losses. The structure is formed by bonding two x-cut lithium niobate thin films with antiparallel c-axis orientations. This specific configuration introduces counter-polarization between the layers, which effectively compensates for the inherent mode mismatch in the phase-matching process. As a result, the platform enables efficient nonlinear optical interactions, such as frequency conversion, while circumventing the complexities associated with domain engineering.

In the optical communication band, we demonstrate a second-harmonic generation conversion efficiency in the QPM TFLN waveguides. The platform further exhibits versatile functionality, supporting efficient difference-frequency and sum-frequency generation, as well as enabling highly efficient on-chip second-harmonic generation within integrated microresonators. Beyond classical nonlinear optics, its applicability extends successfully into the quantum domain: the platform facilitates efficient spontaneous parametric down-conversion, yielding high-performance heralded single-photon sources. This counter-polarized double-layer lithium niobate waveguide platform achieves a marked leap in nonlinear conversion efficiency, not only through the MPM mechanism but also via substantially enhanced mode overlap, while concurrently enabling on-chip preparation of quantum light sources. By circumventing the periodic poling required in conventional QPM approaches, it offers a powerful and streamlined new paradigm for developing integrated, high-efficiency nonlinear optical devices. As such, it presents a compelling new route for advancing integrated high-efficiency nonlinear optical systems and on-chip quantum information processing platforms, with broad prospects for future applications.

References

- [1] Lei Wang, Xiuquan Zhang, Feng Chen, *Laser & Photonics Reviews* 15, 2100409 (2021).
- [2] Xiao-Xu Fang, Hao-Yang Du, Lei Wang, Feng Chen, He Lu, *Laser & Photonics Reviews* 19, 2400782 (2025)
- [3] Haoyang Du, Xiuquan Zhang, Lei Wang, Feng Chen, *Optics Letters* 50, 6269-6272 (2025).
- [4] Haoyang Du, Xiuquan Zhang, Lei Wang, Yuechen Jia, Feng Chen, *Optics Letters* 48, 3159-3162 (2023).
- [5] Lei Wang, Haoyang Du, Xiuquan Zhang, Feng Chen, *Journal of Physics D* 25, 023001 (2025).

Optical Control of Woven Ferroelectric Domains

Feifei Xin^{1,2*}, Yehonatan Gelkop³, Ewout van der Veer⁴, Beatriz Noheda^{4,5}, Ludovica Falsi²,
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The interaction of light with topological polarization textures offers new opportunities for robust and reconfigurable photonic functionalities. While localized ferroelectric topological defects, including vortices and skyrmions, have attracted considerable attention, extended woven domain architectures have not previously been observed in ferroic materials [1-3].

In this work we report the spontaneous formation of a woven ferroelectric domain fabric in lithium-doped potassium tantalate niobate (KTN:Li) crystals during the ferroelectric phase transition [4]. Unlike conventional domain patterns composed of localized topological objects, the woven architecture forms an extended topological network containing a distribution of locked-in charged domain walls. Using focused visible laser illumination, we demonstrate local optical control of the woven fabric. Individual thread-crossing regions can be selectively modified while preserving the integrity of the surrounding network, revealing an unusual coexistence of topological robustness and optical reconfigurability. These results establish woven domain fabrics as a promising platform for reconfigurable photonic functionalities and extended topologically protected photonic memory architectures.

References

- [1] F. Di Mei, et al., Giant broadband refraction in the visible in a ferroelectric perovskite. *Nat. Photon.* 12, 734 (2018).
- [2] A. Yadav, et al., Observation of polar vortices in oxide superlattices, *Nature* 530, 405 198–201 (2016).
- [3] F. Xin, et al., Evidence of 3D Topological-Domain Dynamics in KTN:Li Polarization Supercrystal Formation, *Phys. Rev. Lett.* 132, 066603 (2024).
- [4] F. Xin, et al., Spontaneous formation and optical manipulation of a woven domain fabric in a ferroelectric, *Light Sci. Appl.* 15, 315 (2026).

Exciton Behaviors in van der Waals Materials: Modulation and Optoelectronic Applications

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Van der Waals (vdW) two-dimensional (2D) materials and their heterostructures represent an ideal platform for exploring excitonic physics and developing high-performance optoelectronic devices, thanks to their strong quantum confinement, diverse excitonic states, and tunable light–matter interactions. Excitons in transition metal dichalcogenide (TMD) systems and organic–inorganic vdW heterostructures possess distinctive optical and dynamic properties that are highly responsive to pressure, electric fields, and interfacial engineering, enabling promising advances in advanced optoelectronics and neuromorphic devices.

This talk systematically presents our group's progress on the modulation mechanisms and optoelectronic applications of vdW excitons via multi-dimensional regulation strategies. We demonstrate that mechanical pressure effectively modulates ultrafast interlayer exciton decay and improves carrier mobility in WS₂/MoSe₂ and MoSe₂-based heterostructures, while electric fields enable precise manipulation of interlayer exciton dynamics in TMD heterostructures. In hybrid organic–inorganic vdW systems, we achieve resonant enhancement of hybrid Wannier–Mott–Frenkel excitons and reveal the key role of intersystem crossing in efficient hot electron capture, expanding the modulation framework for low-dimensional excitons.

Guided by these excitonic modulation principles, we develop a series of high-performance functional optoelectronic and neuromorphic devices. The vdW heterojunctions exhibit promoted exciton diffusion via interlayer charge transfer, yielding improved optoelectronic conversion performance. Through ferroelectric engineering, we fabricate reconfigurable homojunctions and full-vdW ambipolar optical heterosynapses, achieving ultra-low sub-fJ programming power for high-efficiency in-sensor photovoltaic computing. We further realize the homogeneous integration of 2D optoelectronic neurons and ferroelectric synapses, constructing high-performance neuromorphic vision hardware with superior signal processing capabilities.

Collectively, our work establishes a versatile toolkit for vdW exciton modulation via interfacial design, external field tuning and hybrid coupling. The tailored excitonic behaviors enable high-performance low-power neuromorphic computing, in-sensor optoelectronic processing and intelligent vision devices. These findings offer fundamental insights and practical guidelines for the development of next-generation vdW excitonic optoelectronic devices.

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Multi-dimensional modulation of ultrafast fiber lasers

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Ultrafast fiber lasers are compact and robust, making them one of the most widely used ultrafast laser sources. However, constrained by the gain, dispersion, and mode field of single-mode fibers, the temporal and spatial characteristics of pulses are limited, which restricts their application scope. For example, in the frequency domain, the laser operates at a single wavelength; in the time domain, pulses exhibit Gaussian or sech² profiles; in the spatial domain, the transverse mode is nearly Gaussian. To address the scientific issue of the singularity of pulse properties in fiber lasers and to meet the demands of difference-frequency terahertz generation and femtosecond machining for novel mode-locked lasers, we introduce additional control dimensions—such as frequency-phase modulation, strong birefringence, and transverse-mode manipulation—into the fiber laser cavity. As a result, we have discovered multi-wavelength composite solitons [1–3], birefringence-managed solitons [4,5], and vector vortex solitons, and have solved key challenges including synchronization of multi-wavelength pulses and generation of transform-limited pulses in the normal-dispersion regime.

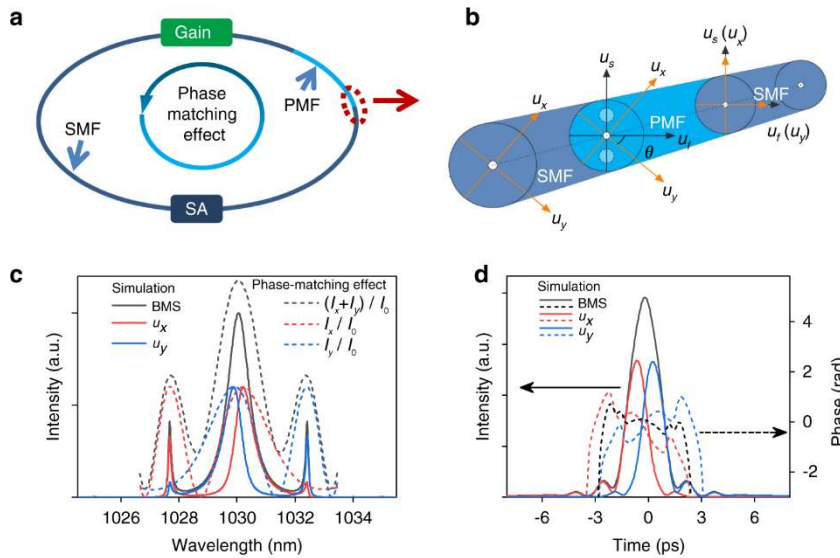


Figure Birefringence-managed solitons

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Electromechanically programmable optical metasurfaces for dynamic light-field manipulation

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Freely programmable manipulation of light at nanoscale is highly desirable in urgent applications such as photonic integration, metasurfaces and optical metamaterials. This talk presents our recent advances in electromechanically programmable optical metasurfaces and their applications on dynamic light-field manipulation, based on the state-of-the-art nano-kirigami technology. Built on Au/SiO₂/Si substrates, these metasurfaces achieve reconfigurable 3D deformations via electrostatic forces, enabling versatile optical modulation at optical wavelengths. Key achievements include broadband non-resonant and narrowband resonant reconfigurations at visible-near-infrared wavelengths, as well as their applications in high-resolution optical information displays with 3.87 million pixels. Additionally, on-chip dynamic information encryption is further demonstrated in SOI based platforms. Compatible with CMOS processes, these metasurfaces could offer scalable and integrable solutions for advanced MOEMS/NOEMS, high-speed spatial light modulations, and reconfigurable photonics, etc.

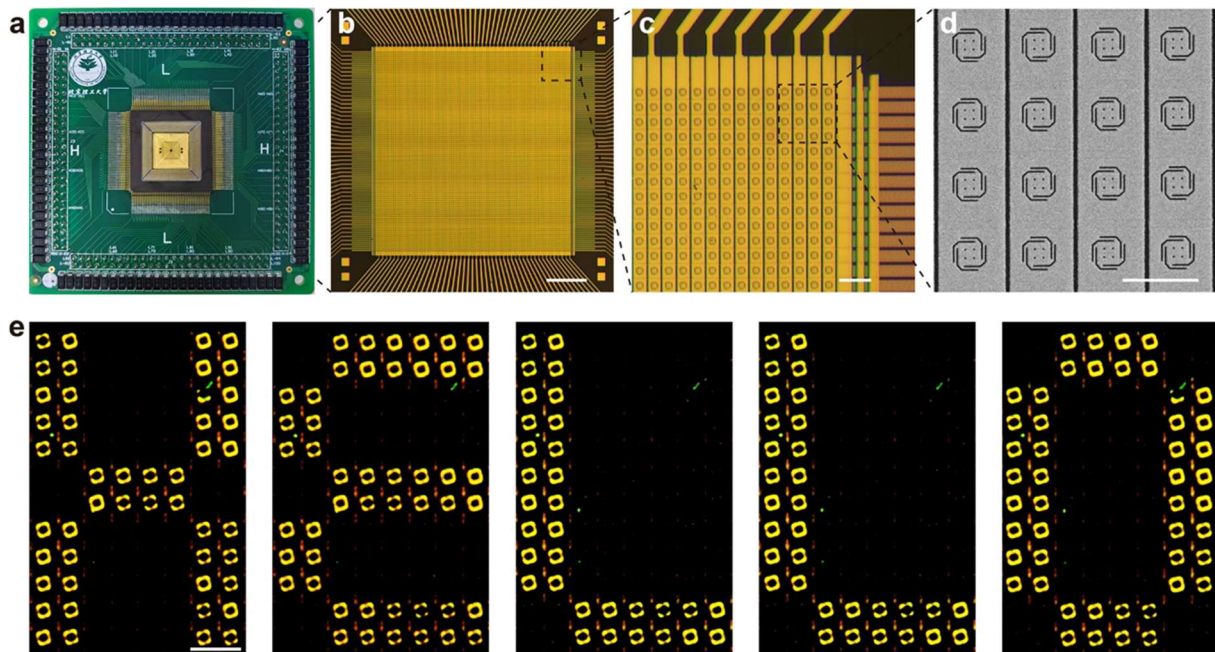


Figure - Electromechanically programmable optical metasurfaces for high-resolution optical information displays.

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Lithium Niobate Photonic Integrated Circuits

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Recent advances in thin-film lithium niobate (TFLN) photonic integration have been driven by a plethora of breakthroughs in material science, device physics, and fabrication technologies. Single-crystal TFLN has emerged as a highly promising platform, offering exceptional performance that addresses long-standing challenges in photonic integrated circuits (PICs), including ultra-low propagation loss, high integration density, and efficient modulation. In this work, we introduce photolithography-assisted chemo-mechanical etching (PLACE) as a novel approach for scalable fabrication of high-quality TFLN photonic circuits. Using PLACE, we demonstrate a range of integrated components and systems, including ultralow-loss delay lines, integrated photonic neural networks, electro-optically tunable lasers, and high-gain waveguide amplifiers. These devices exhibit state-of-the-art performance across key metrics such as modulation bandwidth, power efficiency, insertion loss, and functional versatility. Our results highlight the potential of PLACE-based fabrication for enabling large-scale, high-performance TFLN photonic systems with enhanced integration capability and functionality.

Structured Light: Tailoring Optical Fields Towards Nonlinear Dynamics

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Structured light has become a powerful platform for engineering the spatial phase, amplitude and polarization of optical fields, providing unprecedented opportunities for controlling light-matter interactions [1]. Beyond their remarkable linear propagation properties-including orbital angular momentum (OAM), self-healing, diffraction-resistant propagation and accelerating trajectories-structured beams offer additional degrees of freedom for tailoring nonlinear optical phenomena.

In this invited presentation, I will provide an overview of our recent research on the interplay between structured light and nonlinear photorefractive media. I will first introduce the fundamental properties of structured beams before presenting how Airy and Bessel beams can be exploited to realize robust all-optical steering, routing and photo-inscription of complex three-dimensional waveguide structures [2,3]. These studies demonstrate how beam shaping can be translated into versatile nonlinear optical functionalities.

The second part of the talk will focus on the role of orbital angular momentum in nonlinear beam interactions. Recent results obtained with structured Bessel beams and with counterpropagating Airy-vortex beams will illustrate how phase topology influences nonlinear propagation, optical routing and the emergence of complex spatiotemporal dynamics [4,5]. Particular attention will be devoted to the interplay between structured wavefronts, local orbital angular momentum and nonlinear self-organization [6].

Finally, future perspectives on structured light combined with nonlinear optical media will be discussed, highlighting emerging opportunities for dynamically reconfigurable photonic devices, adaptive waveguide architectures and advanced all-optical light control.

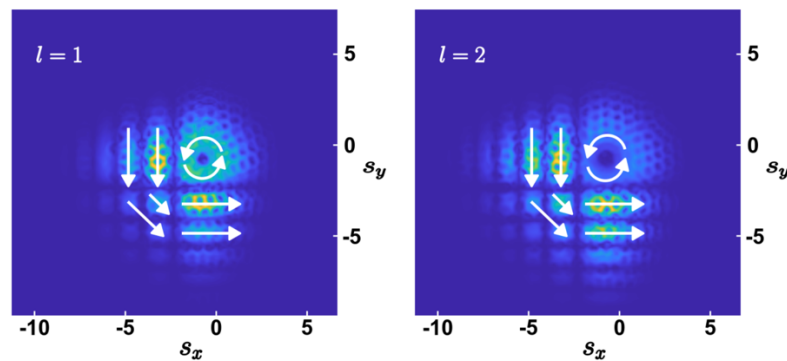


Figure 1 : Simulated dynamics of optical patterns induced by counterpropagating Airy-Gaussian-Vortex beams in a photorefractive crystal for different topological charges ($l = 1$ or 2). Arrows indicate the motion of the pattern in different areas : rotation, drift, advection.

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High-Efficiency 3D Nonlinear Photonic Crystals Based on Laser Direct Writing

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Three-dimensional nonlinear photonic crystals (3D NPCs) offer full spatial control of second-order nonlinearity for nonlinear wave-front shaping, but their practical use has been limited by weak conversion efficiency and demanding fabrication. We report an efficient ferroelectric 3D NPC fabricated by optimized femtosecond laser direct writing/poling. By enabling deep writing, reducing unwanted refractive-index modification, and replacing a continuous spiral $\chi(2)$ pattern with a fabrication-friendly four-segment nonlinear hologram, we realize collinear second-harmonic vortex generation from a Gaussian fundamental beam. The 1 mm-long structure generates a vortex beam with topological charge $l_c = 1$ and normalized efficiencies of $2.9 \times 10^{-6} \text{ W}^{-1}$ under femtosecond-pulse pumping and $1.2 \times 10^{-5} \text{ W}^{-1}$ under continuous-wave pumping, more than four orders of magnitude higher than previous 3D NPC demonstrations and comparable with 1D/2D NPCs. This simplified design strategy provides a scalable route to efficient nonlinear orbital-angular-momentum conversion, multiplexing, and high-dimensional quantum-light sources.

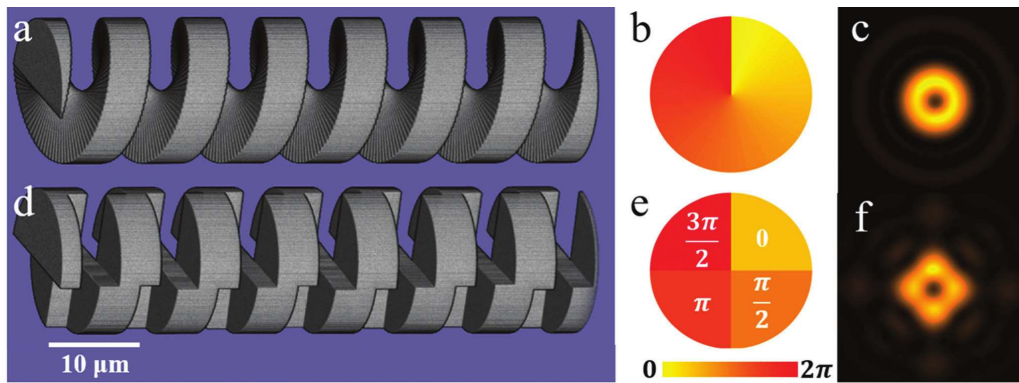


Figure 1. 3D nonlinear holograms for second-harmonic vortex generation: ideal spiral and four-segment discretized designs with calculated phase and intensity (from Fig. 3 in Ref. [1]).

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Dye-Doped Liquid Crystal Mediated All-Optical Tuning of Dielectric Metasurfaces

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An all-optical, fully reversible process of fast control of quasi-bound-state resonances in the near-infrared in a dielectric metasurface infiltrated with dye-doped liquid crystal (LC) is presented. We exploit the light-induced order modification mechanism (LIOM) [1] to induce local LC molecules rearrangement and actively modulate optical anisotropy via photoisomerization of dye molecules under low-power excitation at 532 nm. Our approach eliminates the need for pre-alignment layers, allowing LC molecules to reorient freely, achieving fully reversible, sub-second switching. Furthermore, we demonstrate a continuous tuning mechanism by changing the polarization and power of the excitation light, offering a novel degree of metasurface control. With the metasurface structure designed to support high-Q quasi-bound states in the continuum in the near-infrared [2], we obtained efficient resonance control with a modulation depth greater than 56%.

Compared with earlier approaches based on plasmonic structures or alignment layers, our method offers a simpler, faster, low-loss and scalable route to light-driven reconfiguration. By combining fast response, high modulation depth, and complete reversibility without the need for thermal erasure, this platform establishes a new paradigm for tunable photonics. Our results open pathways to next-generation optical switches, dynamic beam shapers, and programmable holographic devices that demand agile, energy-efficient control.

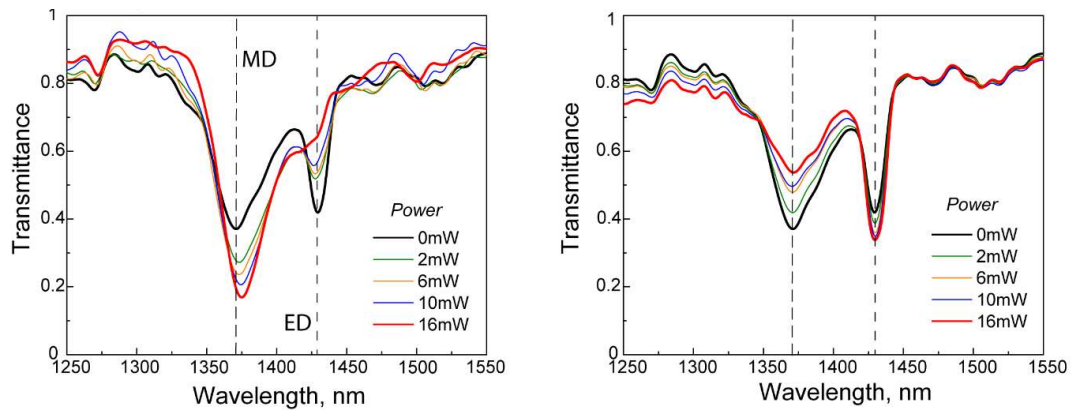


Figure - Power-dependent transmission spectra of dye-doped LC enclosed metasurface under 532 nm laser excitation polarized linearly along the y- (left) and x-axis (right).

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Nonlinear Coupling and Mode Conversion for Vortex Beam Generation in Waveguiding Nonlinear Photonic Crystals

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Abstracts: We generated HG₁₀ mode of 602 nm signal waves from dual-optical parametric oscillations (OPO) on periodically-poled lithium tantalate (PPLT) nonlinear photonic crystals (NPC) with bi-grating structures and its subsequent conversion into LG₀₁ vortex beam with $\pi/2$ optics. This was ascribed to positive refractive index increase $\Delta n \sim 5 \times 10^{-5}$ in the quasi-phase-matching (QPM) structures which enable the nonlinearly coupled waveguides to exhibit odd-parity mode conversion in the OPO regime.

Structured light such as vortex beams are important light sources for quantum information processing and bio-imaging. Vortex beams can be conventionally generated using meta-structures, phase plates, and spatial light modulators (SLM) to convert fundamental input beam of Hermite-Gaussian (HG) HG₀₀ mode into high-order Laguerre-Gaussian (LG) modes. [1-3]

We demonstrated a new approach to achieve wavelength and mode conversion on dual-QPM structures in the nonlinear optics regime. The wave-guiding mechanism was due to combined effects of pyroelectricity and electro-optics related to periodically charged domain boundaries in the QPM structures. Using phase-shifting interferometry, we resolved positive refractive index increase $\Delta n \sim 5 \times 10^{-5}$ in bulk PPLT. We then characterized the output mode patterns and the Mach-Zehnder self-interferometric patterns by operating the coupled PPLT waveguides in the *linear* and *nonlinear* optics regime. The characterization setup were shown in Fig.1(a) with PPLT set at 101.2 °C. The side-lobes of green beam output in Fig. 1(b) exhibit nearly in-phase nature of even parity when PPLT is operated in the linear optics regime. In contrast, in the nonlinear optics regime, analysis from dual-OPO side lobes of 602nm signal waves in Fig.1(b) suggest a π phase-shift which agrees with simulation with odd parity mode. By using a pair of cylindrical lens as $\pi/2$ optics after the coupled-PPLT waveguides, the dual OPO output of HG₁₀ mode was converted into LG₀₁ mode. The latter were confirmed in Fig. 1(d) with a beam shape of donut and characteristic fork and spiral self-interference pattern, in addition to π -phase slipped in the grating- or concentric ring-like fringes observed with the other side-lobe.

In summary, we observed simultaneously nonlinear optical mode and wavelength conversion in dual-OPO operation of bi-QPM grating PPLT. This was ascribed to the QPM-induced waveguiding effect which enable odd-parity output mode when operated in the nonlinear optics regime.

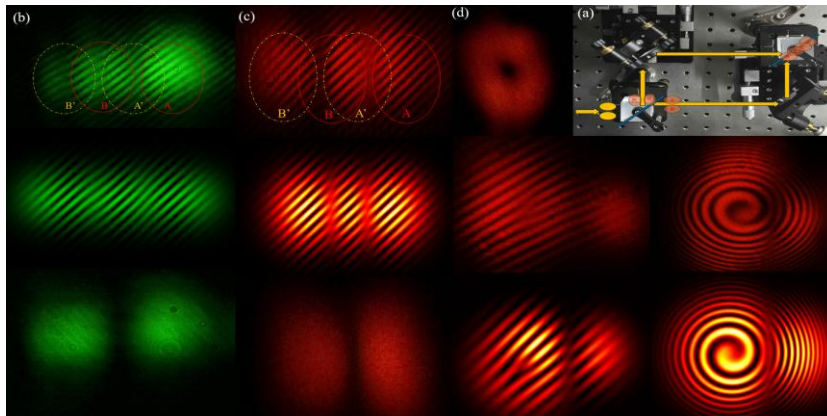


Figure 1– Output mode patterns and interference patterns from a 30mm-long PPLT with bi-QPM grating periodicity 12.74 μ m, width 1mm, and separation by 24 μ m. (a) interferometric setup with PPLT set at 101.2 °C and pumped by 532nm HG₀₀ beam, (b) in the linear optics regime, (c) in the OPO regime, (d) added with $\pi/2$ optics to convert OPO HG₁₀ mode into LG₀₁ mode.

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(Preferred oral contribution)

Observation of Goos-Hänchen Shift under Normal Incidence in Slanted TiO_2 Nanogratings

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Abstract: Goos-Hänchen (GH) shifts at natural optical interfaces are typically small. Recent studies have shown that strong optical resonances of metasurfaces and nanogratings can dramatically enhance the GH shifts. However, GH shifts are typically observed when light is obliquely incident while those under normal incidence have rarely been explored. Here, we demonstrate, both theoretically and experimentally, that GH shifts can also be realized under normal incidence by employing slanted TiO_2 nanogratings. The slight slant of the nanograting introduces symmetry breaking, enabling quasi bound states in the continuum (Q-BICs) with extremely high Q factors. Because the transmission phase $\phi(k)$ becomes asymmetric with the in-plane wavevector k , its derivative $d\phi(k)/dk$ acquires a large magnitude at $k = 0$. This steep phase variation results in the observable normal-incident GH shifts. Experimentally, we use reactive ion beam etching for high-quality TiO_2 slanted nanogratings. The presence of Q-BICs resonances was revealed by reflection spectra measurements, and the corresponding GH shifts were measured using light-field detection scheme. Our results reveal normal-incidence GH shifts, thereby opening a new route for compact, on-chip beam-steering devices that operate without the need for angular alignment.

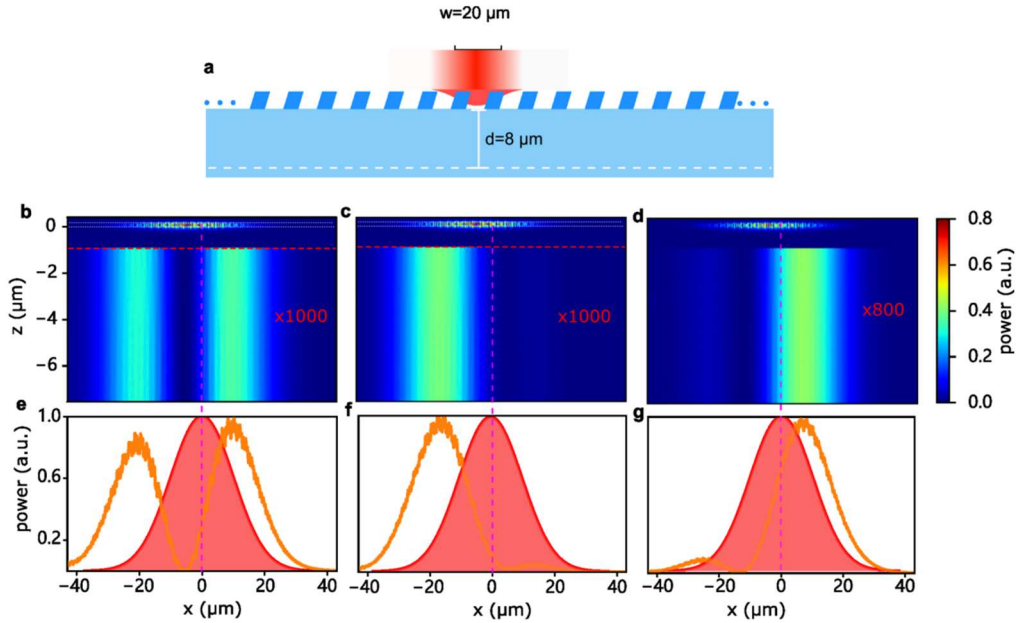


Figure - Simulated transmitted beam profiles at wavelengths of 780 nm, 781 nm, and 779.5 nm, showing opposite lateral shifts under normal incidence.

Metasurface-Based Near- and Far-Field Vector Holography

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Metasurface, with its capability for multidimensional light field manipulation at subwavelength precision, has demonstrated significant potential in both near-field and far-field optical modulation. Current research efforts are focused on achieving synergistic control over amplitude and polarization in the near and far fields using single-layer metasurfaces to enhance optical information processing capabilities. However, existing technical approaches still face substantial challenges in achieving freely customizable optical parameters. This study proposes a novel metasurface architecture based on vectorial manipulation. By designing the arrangement of nanostructured supercells and incorporating an improved Gerchberg-Saxton (GS) optimization algorithm, independent control over near-field and far-field optical characteristics has been successfully achieved. Experimental results demonstrate that this approach can precisely regulate amplitude distributions and polarization states in both near-field and far-field regions, overcoming the limitations of conventional metasurfaces in optical parameter manipulation. This research not only provides a new technical pathway for near- and far-field optical modulation, but its design philosophy can also be extended to various cutting-edge fields, including optical encryption, specialized beam generation, and high-density optical data storage, holding significant importance for advancing the development of micro-nano optical devices.

Group-velocity engineering and topological light stopping in photonic lattices through long-range couplings

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Continuous group-velocity control of multichannel topological edge states remains a major challenge. Here, We introduce next-nearest-neighbor (NNN) couplings into a Harper – Hofstadter (HH) model photonic lattice to construct a long-range topological photonic model. We show that the NNN couplings open a previously closed band gap and induce spectral compression of the gap modes compared with those in the corresponding nearest-neighbor HH model. By defining the band-gap Chern number, we reveal the coexistence of counter-chiral edge states. Further band-structure analysis demonstrates that the NNN couplings enable continuous tuning of the group velocities of the counter-chiral edge states across a broad range. The system can also realize topological light-stopping effect arising from the spectral compression of the gap modes. Moreover, by varying the NNN coupling parameters, controllable transitions between fast and slow light can be achieved. These results establish long-range NNN coupling as a powerful mechanism for dynamical control in topological photonic lattices and provide new design principles for topological slow-light devices, delay lines, and integrated multichannel photonic systems.

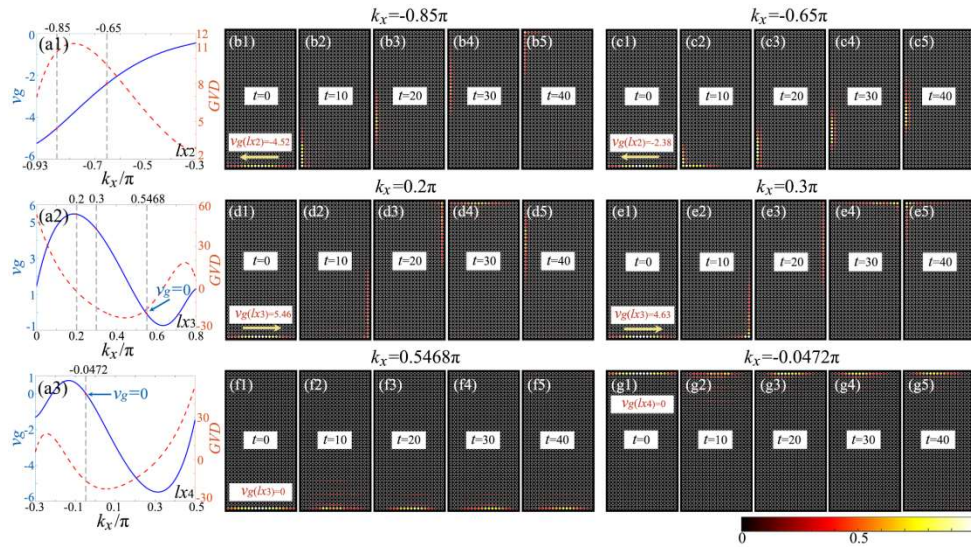


Figure - Group-velocity engineering of counter-chiral edge states. (a1-a3) Group-velocity and GVD curves of edge states in the first and third band gaps. The group velocities of edge states l_{x3} and l_{x4} become zero at specific wave vectors. (b1-c5) Clockwise edge transport in the first band gap for different group velocities. (d1-e5) Counterclockwise edge transport in the third band gap for different group velocities. (f1-g5) Topological light stopping induced by vanishing group velocity.

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Tunable OAM interaction between phase and intensity singularities

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Unlike traditional vortex beams, cyclonic catastrophe vortex beams (CCVBs) exhibit unique characteristics, arising from the interaction between phase and intensity singularities. These beams not only possess spiral wavefronts and carry orbital angular momentum (OAM), but also form a central bright spot at the focal plane during autofocusing propagation, even in the presence of a vortex phase. Remarkably, CCVBs can exhibit rotational behavior during propagation even without a nonzero topological charge. The topological charge of the vortex phase plays a crucial role in shaping the beam's propagation dynamics, allowing precise control over the size and intensity of the central spot by tuning the OAM. This tunable bright core enables CCVBs to stably trap polystyrene particles, while their surrounding side lobes can simultaneously rotate other particles around the beam center. Such capabilities go beyond those of conventional vortex beams, offering enhanced flexibility and performance for optical manipulation. These findings deepen our understanding of the interplay between phase and intensity singularities and pave the way for new applications in advanced optical manipulation and high-resolution imaging.

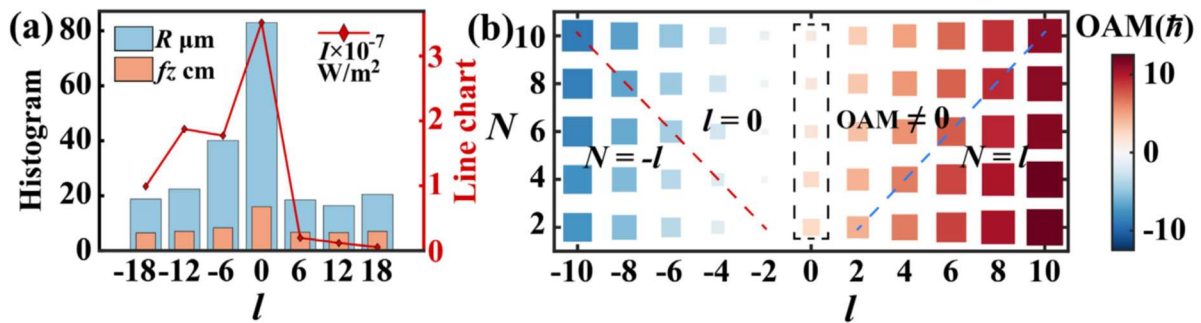


Figure - (a) The variation of beam radius R , autofocusing length f_z and peak intensity I with different TCs l . (b) The total OAM per photon

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Enhanced Photorefractive Response Speed in W- and Zr,W-Doped LiNbO₃ Crystals in the Visible Band

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Abstract: With the rapid development of lithium niobate on insulator (LNOI) technology, lithium niobate (LiNbO₃, LN)-based photonic devices are being continuously scaled down to micro- and nanoscale dimensions. The photorefractive (PR) effect, particularly its response speed, becomes increasingly important for device stability, dynamic optical modulation, and reconfigurable photonic applications [1]. Since LNOI thin films are generally fabricated from high-quality LN single-crystal substrates, regulating the PR response behavior of bulk LN crystals remains of fundamental and practical significance. In this work, W-doped and Zr,W co-doped LiNbO₃ crystals were grown by the modified Bridgman method. For singly W-doped LN crystals, the response speed was significantly improved compared with congruent LiNbO₃ [2]. In particular, LN:W_{2.2} exhibited the best overall response behavior, with response times shortened to the second scale under blue and green illumination, and to the tens-of-seconds scale under red illumination. After further incorporation of Zr, the PR response of LN:Zr,W crystals was further accelerated over the whole visible range [3]. The response time was reduced to the sub-second level in the blue region and remained at the second scale in the green region. More importantly, under red illumination, the response time was shortened from tens of seconds to the second level, indicating a more balanced and rapid PR response across different wavelengths. These results suggest that Zr,W co-doping can effectively regulate defect-related charge transport and trapping processes in LN crystals, thereby enhancing the PR response speed over the visible spectrum [4-5]. This work provides a useful doping strategy for developing fast-response LN-based photorefractive materials for dynamic holography, optical information processing, and reconfigurable photonic systems.

Keywords: LiNbO₃ crystals; Photorefractive speed enhancement; Tungsten doping; Zirconium co-doping.

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Progress in Lithium Niobate-Based Photovoltaic Manipulation Technology for Fluids and Solids

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Abstract

In recent years, lithium niobate-based photovoltaic manipulation technology has gradually attracted attention and is expected to become a key supporting technology for the manipulation functions of lithium niobate-based biophotonic chips. This photovoltaic micro-nano manipulation technology typically uses transition metal (iron, copper, etc.) doped lithium niobate crystals with significant bulk photovoltaic effects as substrates, and utilizes the electrostatic interaction of the non-uniform photovoltaic space-charge field, which is spatially regulated on the lithium niobate surface, with fluid and solid targets to achieve contactless manipulation. This paper reports progress in real-time manipulation research on microfluids and microparticles based on the photovoltaic effect. It provides a detailed introduction to the active and passive photovoltaic manipulation behaviors and physical mechanisms on various modified iron-doped lithium niobate substrates, mainly including the manipulation and assembly of spherical and rod-shaped particles in lithium niobate-based oil phases and related photonic applications, as well as microdroplet charging on lithium niobate-based superhydrophobic surfaces and three-dimensional spatial droplet transport [1-6].

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On-Chip Nonlinear Optical Physical Unclonable Function Based on Thin-Film Lithium Niobate Array

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We propose and simulate an optical physical unclonable function (PUF) scheme that exploits nonlinear modulation in an integrated thin-film lithium niobate (TFLN) scattering array. The device consists of a silica grating structure, which randomly scatters components of different wavelengths, and a random lithium niobate array, which induces mutual temporal modulation among the input signals. First, simulations examine the wavelength-dependent scattering and the resulting nonlinear effects, confirming the theoretical basis for temporal encryption via mutual modulation in the lithium niobate pattern. Next, simulations verify the PUF's unpredictability, reproducibility, and unclonability. By varying the challenge wavelength and its coding format, we further demonstrate a strategy for expanding the challenge-response pair (CRP) space, which is calculated to be approximately one million. Subsequently, an identity authentication scheme is proposed, and its security under link attacks is analyzed. This work lays the foundation for the design and implementation of TFLN PUF and provides a new security authentication solution for IoT devices.

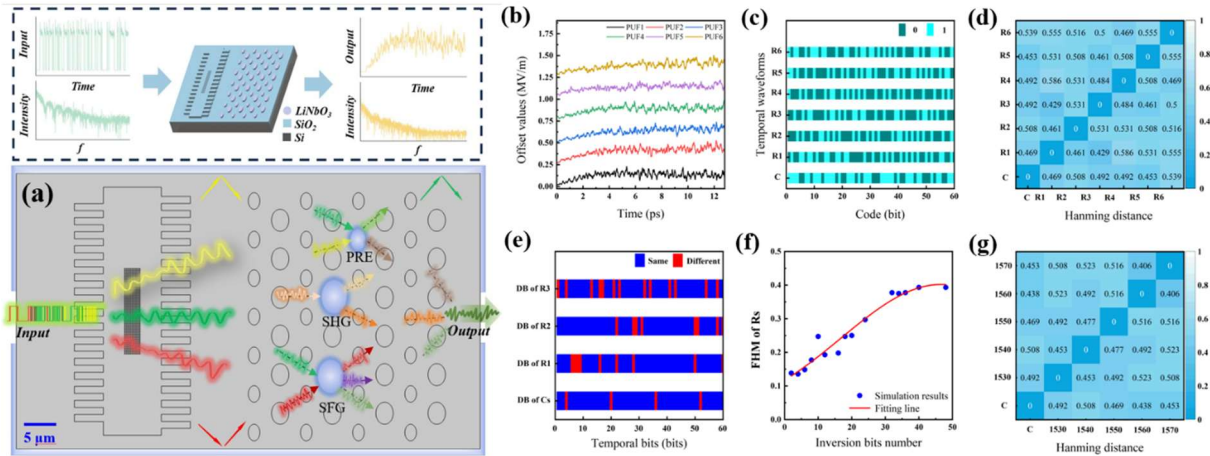


Figure – (a) Schematic diagram of the structure and operating principle of the PUF scheme; **(b)** output temporal waveforms of the six PUFs; **(c)** quantized results; **(d)** fractional Hamming distances (FHD) between each pair of binary codes shown in (b); **(e)** bit differences between the responses and the challenges; **(f)** FHDs between responses as the number of inverted challenge bits increases; **(g)** FHDs between responses obtained under different pump wavelengths.

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Efficient self-amplification in monolithically integrated laser on Er/Yb co-doped lithium niobate on insulator

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Light sources constitute an indispensable component in photonic integrated circuits (PICs), with lithium niobate on insulator (LNOI) emerging as an ideal platform for PICs. Although rare-earth ions doping has been employed to introduce optical gain, achieving high output power and high slope efficiency simultaneously remains challenging in micron-scale lasers. Here, we demonstrate a high-performance, monolithically integrated Er/Yb co-doped LNOI laser that leverages a cascaded microring-amplifier architecture. By integrating a spiral waveguide amplifier, the device achieves a significant signal enhancement of 28.21 dB over the sole microring laser. Optimized through a bidirectional pumping scheme at 980 nm and 1480 nm, the laser harnesses strengthened ytterbium to erbium ions energy transfer to reach a maximum output power of 3.94 μ W and a slope efficiency of 0.64%. This work establishes a practical and robust approach for realizing high-performance on-chip lasers, highlighting the strategic advantage of self-amplifying designs for future communication and signal-processing systems.

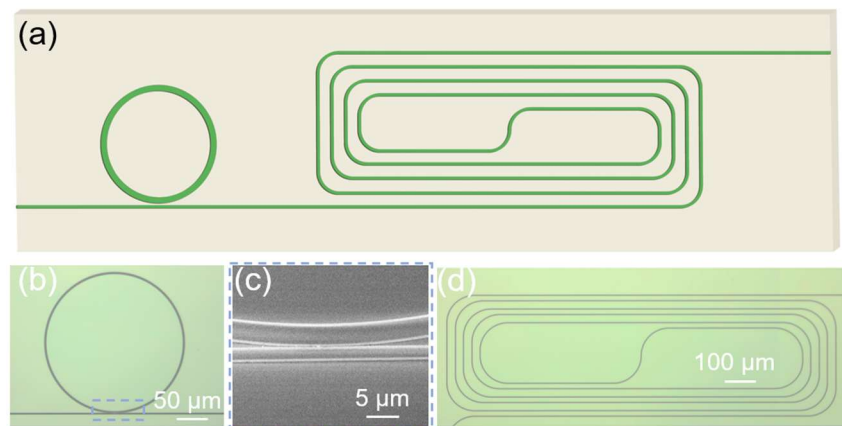


Figure - A monolithic integrated self-amplifying laser.

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Ultra-compact optical (de)multiplexers on 4H-silicon-carbide-on-insulator platform via inverse design

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Silicon carbide-on-insulator (SiCOI) has emerged as a promising platform for integrated photonics, combining a wide bandgap, high thermal stability, CMOS-compatible processing, strong optical nonlinearities and access to solid-state quantum emitters. However, compared with mature silicon photonics, the library of compact passive building blocks on SiCOI remains limited, which constrains dense and scalable photonic integration. Here we present ultra-compact (de)multiplexing devices on a 4H-SiCOI platform enabled by adjoint-based inverse topology optimization. This method can fully explore the design space of fabricable devices without any constraints on geometrical shapes, allowing a more efficient control of the optical field distribution in comparison with conventional methods, and enabling high performance within a small footprint. For wavelength routing, the inverse-designed wavelength (de)multiplexing device (WDM) separates the fundamental TE₀ mode in the C and L bands into two output ports within a footprint of only 8 $\mu\text{m} \times 4 \mu\text{m}$ [1]. Experimentally, the fabricated WDM exhibits peak transmissions of -0.76 dB in the C band and -0.74 dB in the L band, with extinction ratios of 17 dB and 11 dB. Beyond wavelength selectivity, we further demonstrate a broadband two-mode TE₀/TE₁ mode-division (de)multiplexer using the similar inverse-design strategy within an 8 $\mu\text{m} \times 4 \mu\text{m}$ footprint [2]. Experimentally, the TE₀ channel maintains an insertion loss below 0.75 dB and crosstalk below -13 dB from 1500 to 1630 nm, whereas the TE₁ channel maintains an insertion loss below 2 dB and crosstalk below -10 dB from 1541 to 1630 nm. In addition, subwavelength grating assisted grating couplers are introduced as fiber-to-chip interface components to suppress chip-interface back-reflection [3], mitigating reflection-induced spectral perturbations and improving measurement stability [2]. These results highlight inverse design, together with reflection-suppressed fiber-to-chip coupling, as a powerful route toward compact and multifunctional 4H-SiCOI photonic circuits for optical communications, nonlinear photonics, quantum photonics and optical computing.

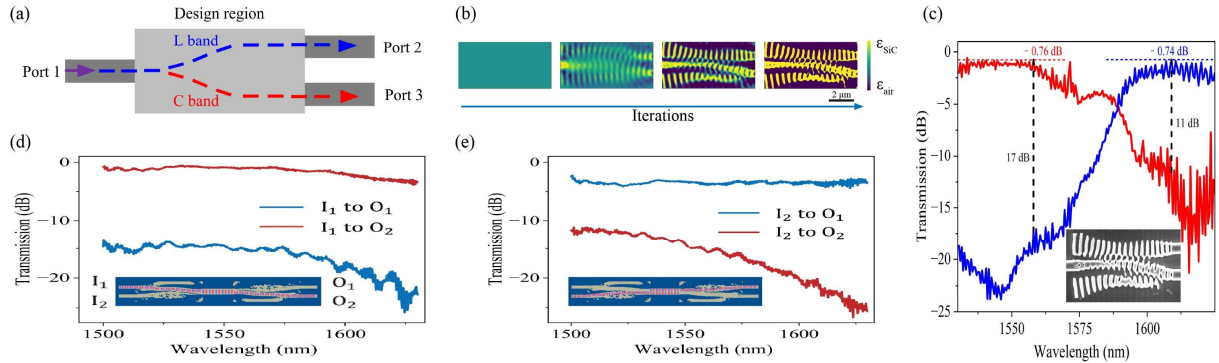


Figure 1. (a) Schematic of the two-channel WDM. (b) Topology evolution during inverse design, showing the transition from an initial uniform distribution to a binary SiC/air structure. (c) Measured transmission spectra of the WDM. The inset shows the SEM image of the fabricated device. (d) and (e) are the measured transmission spectra for TE₀ mode input and TE₁ mode input for the MDM, respectively, showing broadband efficient routing along with low crosstalk.

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On-Chip Acousto-Optic Superlattice Modulation Based on Surface Acoustic Wave and Micro-Nano Optical Waveguide

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Acousto-optic effect has been proven to be an effective mechanism for modulating the phase, intensity, frequency, and direction of on-chip optical fields, with modulation frequencies up to the GHz level. This study proposes on-chip acousto-optic superlattice modulation effect and devices, to enlarge the momentum matching range for on-chip acousto-optic modulation, which can significantly improve the tuning range and accuracy of on-chip acousto-optic devices. As typical cases, on-chip acousto-optic deflectors and fast tunable filters can be realized with fast speed and high precision. Surface acoustic waves (SAWs) are utilized to excite acousto-optic superlattice modulation effects in waveguide Bragg gratings (WBGs).

For SAW characterization, the acoustic wave generated by an interdigital transducer (IDT) is coupled into an on-chip microfiber via acoustic couplant, inducing phase modulation in the fiber [1,2]. This acousto-optic modulation effect enables frequency- and time-domain measurement of SAW devices, with responses consistent with simulations and electrical measurements. Ultrafast swept laser further maps acoustic strain into phase variations of the optical beat signal, enabling mrad-level sensitivity and waveform-resolved detection of the SAW.

For on-chip acousto-optic superlattice modulation, we design a SAW-driven thin-film lithium niobate (TFLN) waveguide Bragg grating. The SAW induces sideband peaks for tunable filtering and modulation. The wavelength tuning response can be engineered through the acoustic wavelength, modulation amplitude, and waveguide geometry. This platform provides a flexible approach for integrated photonic-phononic sensing, microwave photonics, and reconfigurable light-matter interaction.

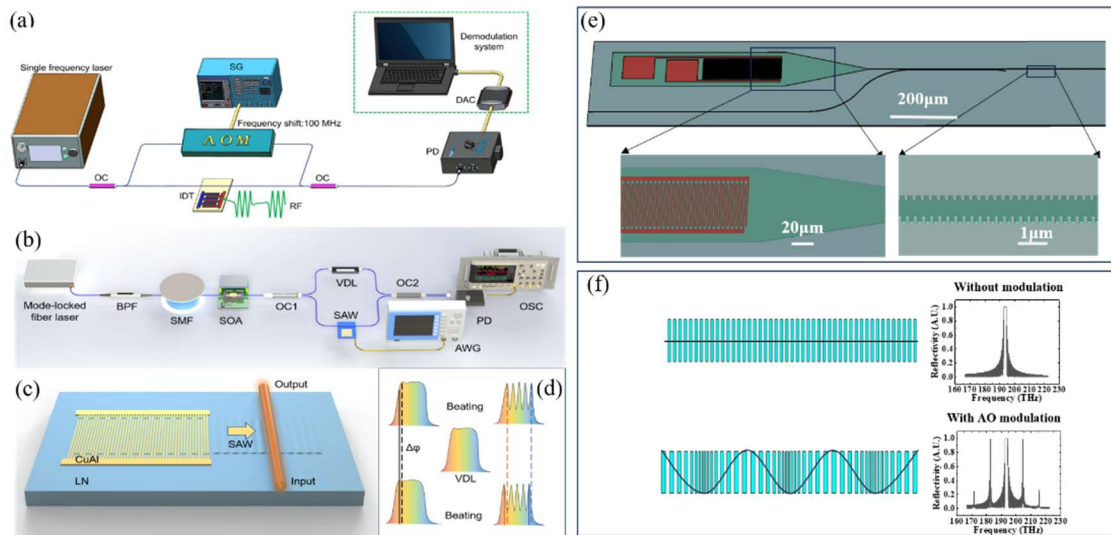


Figure - (a) Microfiber-based SAW phase detection system. (b) SAW detection system based on ultra-fast swept laser. (c) Acousto-optic interaction between the SAW and microfiber. (d) Principle of SAW detection based on the swept-laser. (e) TFLN-based acousto-optic superlattice modulator. (f) Superlattice-modulation-induced sideband resonances.

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Light – Matter Interactions in Ferroelectric Nematics: From Bulk Photovoltaics to Photorefractive Gratings

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Developing dynamically reconfigurable photonic architectures requires media that simultaneously exhibit strong electro-optic coefficients and inherent photoconductivity. Ferroelectric nematic liquid crystals (FNLCs) offer a promising soft-matter platform for these systems due to their fluid nature and large macroscopic spontaneous polarization [1-2]. We have previously shown that this polarization enables a bulk photovoltaic (BPV) effect under ultraviolet illumination at 360 nm, allowing for the determination of the non-zero elements of the BPV tensor, including the β_{33} as component ($\approx 9.86 \times 10^{-7} \text{ V}^{-1}$) [3]. Furthermore, we have demonstrated that FNLCs exhibit high optical nonlinearities, supporting the formation of electric-field-assisted holographic gratings via two-wave mixing at 532 nm with an effective nonlinear refractive index n_2 ($\approx 2.6 \times 10^{-2} \text{ cm}^2/\text{W}$) [4]. However, photorefractivity in conventional liquid crystals typically requires the introduction of molecular dopants and the application of an external bias voltage to facilitate charge separation. Here, we demonstrate the realization of a completely bias-free photorefractive grating within an FNLC phase. By utilizing two-wave mixing at 360 nm, the intrinsic BPV effect spontaneously generates the space-charge fields necessary for index modulation. This process yields a refractive index modulation of $\approx 3.3 \times 10^{-4}$, a first-order diffraction efficiency of around 0.18%, and an effective electro-optic coefficient r_{33} of $\approx 12 \text{ pm/V}$. By unifying the BPV effect with the high electro-optic response of the fluid phase, these results provide a route toward autonomously powered, dynamically reconfigurable soft-matter photonic devices.

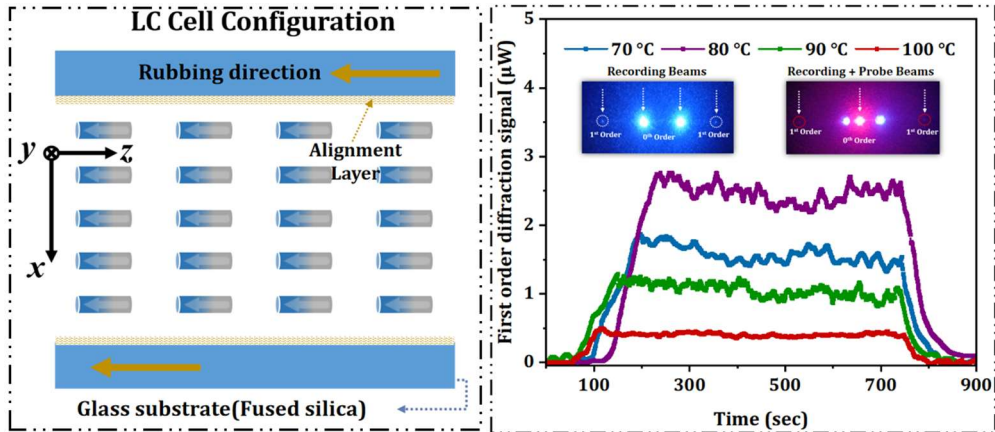


Figure - Model description of phenomenon (left), Experimental measurements of diffraction signal vs time (right)

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Nematic Ferroelectric Liquid Crystals: Bridging the Fundamental Gap Between Solid and Liquid Ferroelectrics through Polar Order in Fluids

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The recent discovery of the ferroelectric nematic (N_F) phase has established a new class of materials that combines the **spontaneous polarization** and **switchable domain structures** of conventional ferroelectric solids with the fluidity, self-organization, and reconfigurability of liquid crystals. This unique coexistence of long-range polar order and liquid-like mobility challenges the traditional view that ferroelectricity requires a rigid crystalline lattice and positions ferroelectric nematic liquid crystals as an ideal bridge between solid-state and liquid-state ferroelectrics. In this presentation, we discuss the fundamental physical principles underlying the N_F phase in representative materials such as RM734 [1] and DIO [2], including the emergence of macroscopic polarization from collective molecular dipole alignment, the formation of polar domains, and electric-field-induced polarization switching. A comparative analysis with conventional ferroelectric oxides and nematic liquid crystals highlights how **ferroelectric nematics** inherit key functionalities from both material classes while introducing entirely new phenomena arising from the coupling between polarization and liquid-crystal elasticity. Particular attention is given to the opportunities offered by **nanoconfinement** and **micro/nano-engineered structures** for controlling ferroelectric order and enhancing **electro-optic performance**. The potential impact of ferroelectric nematics on reconfigurable photonics, adaptive metasurface, flexible electronics, soft actuators, and energy-storage technologies is also explored. By unifying concepts from ferroelectricity, soft condensed matter, and materials nanoengineering, ferroelectric nematic liquid crystals provide a versatile platform for next-generation functional materials and devices, offering unprecedented possibilities for bridging the gap between solid and liquid ferroelectrics.

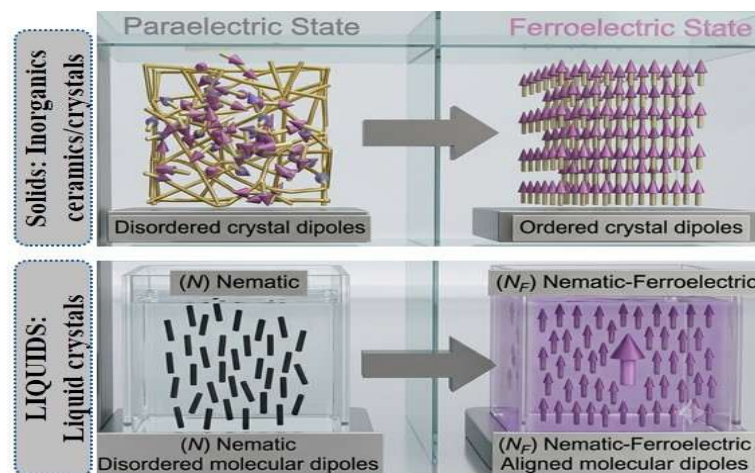


Figure - Comparative schematic of phase transitions and dipole ordered states in solid ceramics/crystals and liquid crystals.

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Ghost imaging with zero photons

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Ghost imaging was first demonstrated with entangled photon pairs and well-known for its peculiar properties. The signal beam that illuminates the object possesses no spatial resolution, whereas the reference beam, which never interacts with the object, is spatially resolved. Either beam alone cannot retrieve the image, which can only be obtained when the signal and reference beams are correlated. Here we will report a ghost imaging experiment with even more peculiar properties, in which the image can be reconstructed when no photon interacts with the object or even no photon in neither signal nor reference beam^[1,2]. All the photons interacted with the object are discarded. Only the time bins with zero photon are employed to retrieve the image, a process referred to as “ghost imaging with zero photons” hereafter. The reason why ghost image can be retrieved with zero photons is jointly determined by photon-number projection measurement and photon statistics of thermal light. Figure 1(a) shows the experimental setup for ghost imaging with zero photons, which is similar as the one for traditional ghost imaging except two-photon coincidence count detection system is replaced by photon detection time series recording system. Figure 1(b) – (d) show the reconstructed images with zero photons in different conditions. For comparison, Fig. 1(e) shows the result with traditional ghost imaging algorithm. The results are helpful to resolve the debate on the physics of ghost imaging and understand the relation between quantum and classical correlations.

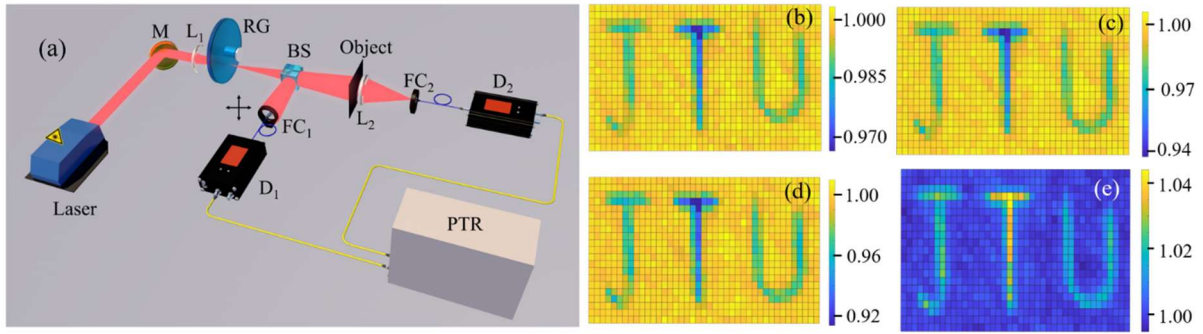


Figure 1- Setup of ghost imaging with zero photons (a), the experimental results of ghost images with zero photons (b-d), and normal ghost image (e).

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Characterize localization length of disordered lattices via critical coupling effect

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Characterizing the localization length is crucial for understanding Anderson localization and wave transport in disordered systems [1], yet precisely measuring the localization length remains challenging due to the inherent multi-mode interference [2]. In this work, we demonstrate a novel far-field approach to determine the intrinsic localization length in two-dimensional disordered lattices (see Figure 1) [3]. By integrating out-of-plane excitation with adaptive wavefront shaping, we implement a spatially matched coupling scheme that enables efficient excitation of the minimal localized state. Through variable-size focusing, we report the first observation of the critical coupling effect when the focusing region matches the minimum localized mode. This critical condition allows us to accurately determine the intrinsic localization length in disordered lattices. We apply this approach to two self-assembled ZnO lattices with different structural parameters. Our results reveal that for a fixed lattice periodicity, increasing the air-hole diameter significantly reduces the minimum localization length. This work establishes a robust framework for probing wave localization in complex media, with potential applications in random lasing and nonlinear photonic devices.

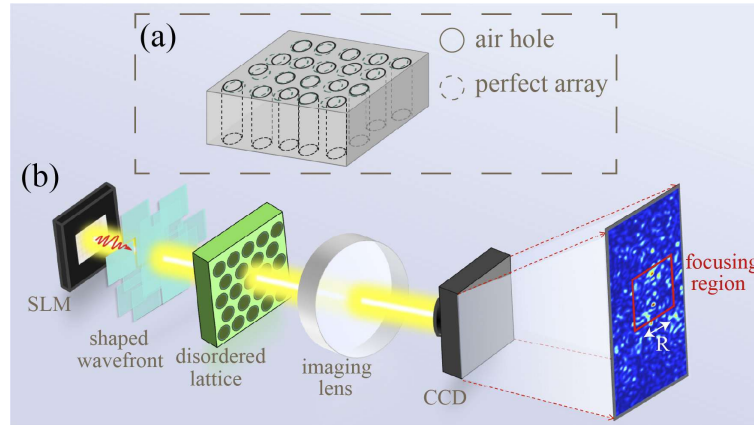


Figure 1 Scheme for characterizing localization length in a disordered lattice. (a) Schematic of the disordered photonic lattice. (b) Conceptual diagram of the spatially matched coupling technique with wavefront shaping.

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Width-reshaped photonic-crystal ring resonators for localized dispersion engineering

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Whispering-gallery-mode resonators are important building blocks for nonlinear and integrated photonics, where efficient nonlinear interactions require precise and localized dispersion engineering. Conventional geometry-based approaches mainly tune modes with specific azimuthal numbers, while multiple-selective mode splitting based on Fourier-synthesis photonic-crystal rings usually requires chirped modulation profiles with increasingly fine scattering features, placing stringent demands on fabrication precision. Here, we demonstrate localized dispersion engineering through multiple-selective mode splitting in a single-period photonic-crystal ring resonator using a width-reshaping strategy. By reshaping the scattering strength within one modulation period, selective splitting of multiple resonances can be achieved without introducing fine structural features, thereby improving fabrication robustness while preserving high optical quality factors. Based on a systematic design framework, we experimentally implement this method on a thin-film lithium niobate platform and realize multiple-selective mode splitting over a 10-nm spectral engineering bandwidth, with a highest loaded Q factor of 5.5×10^5 after splitting. This approach provides a robust and fabrication-friendly route for localized dispersion control in high-Q resonators, and may benefit nonlinear frequency conversion, optical parametric processes, and high-performance photonic integrated circuits.

Key words

Width reshaping; Localized dispersion engineering; High-Q WGM resonators

Dynamic visualization of the photorefractive effect via single-pixel complex-amplitude imaging

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Abstract: Quantitative characterization of the photorefractive evolution is essential for both fundamental studies and device engineering. Traditional characterization techniques primarily rely on Sénarmont compensation⁰, Mach-Zehnder interferometry⁰, and diffraction-based methods⁰. While these approaches offer high precision for measuring static refractive index distributions, they often struggle with long-term dynamic visualization.

To address this limitation, we propose a single-pixel complex-amplitude imaging (SPCI)⁰ for quantitative dynamic visualization of the photorefractive effect in an iron-doped lithium niobate crystal. As shown in Figure 1. (1), a 532 nm Gaussian beam locally pumps the crystal, while a uniform 632.8 nm illumination probes the photoinduced refractive index changes. Benefiting from its common-path self-referenced architecture, SPCI exhibits strong environmental robustness, enabling stable, continuous observation of refractive index evolution. Experimental results are presented in Figure 1. (2), which clearly resolve the spatial anisotropy and temporal progression of the photorefractive effect, further revealing a distinct polarization-dependent saturation behavior. This method provides a reliable experimental means for probing photorefractive dynamics, facilitating deeper insight into underlying mechanisms and supporting device optimization.

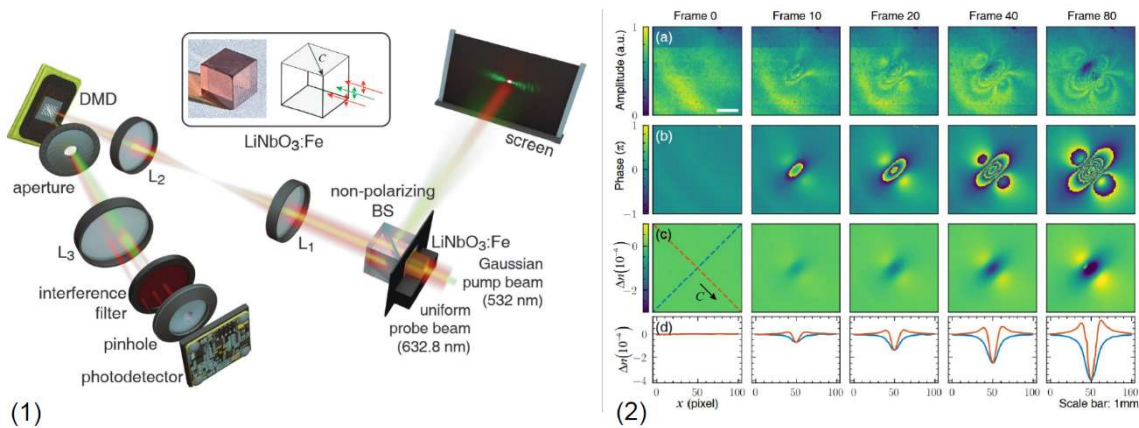


Figure1. Experimental setup and experimental results for vertical pump and horizontal probe. (1): Schematic of the experimental setup. Insets show a photograph of the LiNbO₃ crystal (left) and its orientation (right). The black arrow denotes the positive c-axis direction; green and red arrows indicate the pump and probe beams, respectively. (2): Experimental results. Rows (a) and (b) amplitude and phase images of sampled frames; row (c) spatial distributions of effective refractive index change Δn , row (d) Δn profiles along diagonal (red) and anti-diagonal (blue). The black arrow indicates the projection of the c-axis onto the exit surface.

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Interplay of Flat-band and Anderson localizations in disordered moiré superlattices

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Moiré photonic lattices introduce long-period interference modulation through twisting or lattice mismatch, enabling band reconstruction and the formation of nearly dispersionless flat bands with strong spatial localization and low group velocity^[1,2]. This makes them important for enhancing light-matter interactions^[3,4]. However, finite-size effects and structural disorder break the ideal symmetry, and their impact on flat-band localization remains poorly understood^[5]. In this work, we use a one-dimensional disordered moiré photonic lattice as a model to study the localization evolution of flat-band states under disorder. By introducing controllable random perturbations and analyzing the density of states, differential probability density, and inverse participation ratio, we reveal the competition between flat-band localization and disorder-induced scattering. It is found that flat bands confined within the interband gap keep their strong localization even as disorder grows. In contrast, flat bands intersecting dispersive bands exhibit rich behaviors: the low-frequency branch undergoes an inverse Anderson transition, while the high-frequency branch supports coexisting flat-band and Anderson localization at strong disorder. Our results provide direct evidence of competing localization mechanisms in disordered moiré systems and offer guiding principles for engineering robust, nonideal moiré photonic devices.

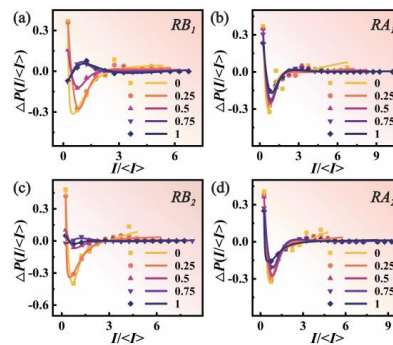


Figure - Statistical differential probability density ΔP for different flat bands under increasing disorder. For the RB group, disorder causes a transition from localization to delocalization (inverse Anderson transition). The RB_2 band becomes localized again at high disorder. In contrast, the RA group shows reduced localization but still retains localized behavior even under strong disorder.

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Virtual-Depth Photonic Reservoir Computing for High-Speed Neuromorphic Signal Processing

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Photonic reservoir computing has emerged as a promising hardware paradigm for energy-efficient artificial intelligence, offering high-speed information processing through the intrinsic dynamics of optical systems. While free-space optical reservoir computing architectures provide excellent scalability and parallelism, their performance remains limited by the modulation speed of conventional spatial light modulators and by the representational capacity of shallow reservoir architectures [1-3].

In this work, we present a deep binarized photonic reservoir computing architecture combining ultrafast binary modulation using a Digital Micromirror Device (DMD), multiple optical scattering in a random medium, and high-speed CMOS photodetection within a hierarchical time-multiplexed framework [4]. We demonstrate the capabilities of the proposed architecture on representative multimedia processing benchmarks involving image, video and speech recognition. Classification accuracies exceeding 95% are obtained on MNIST handwritten digit recognition, KTH human action recognition and TI-46 spoken digit recognition tasks, while maintaining real-time operation and moderate network complexity [4].

Beyond benchmark performance, we perform a systematic investigation of key architectural parameters including network depth, layer-wise neuron allocation, leakage-rate scheduling and bias optimization. Our results show that carefully engineered deep reservoir hierarchies significantly improve spatiotemporal feature extraction and temporal memory capabilities compared to conventional shallow reservoir architectures. In particular, decreasing neuron allocation and leakage-rate scheduling across layers are shown to enhance the hierarchical processing of multimedia information.

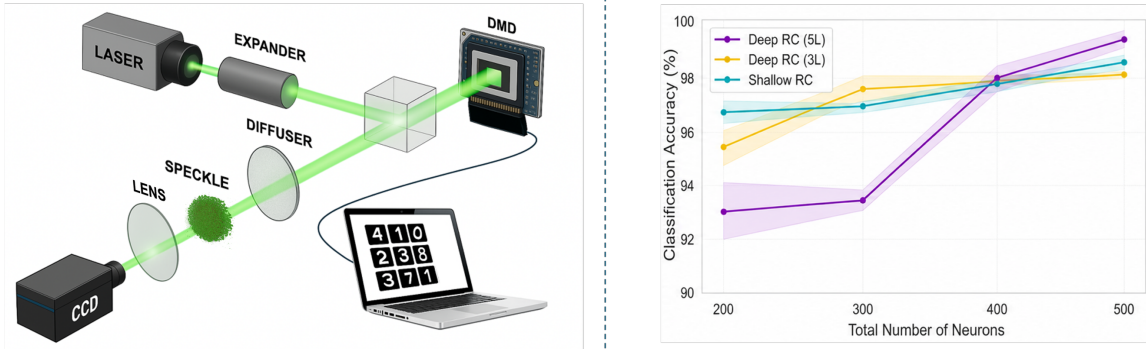


Figure 1- Left : Experimental implementation of the deep photonic reservoir computing system based on DMD binary modulation, optical scattering and CMOS detection. Right : Classification results obtained for the TI-46 audio recognition task, across network depths of 2 to 5 layers (L) while maintaining a fixed total neuron budget of $N = 100 \times L$

These results establish deep photonic reservoir computing as a promising route toward scalable neuromorphic photonic hardware for high-throughput artificial intelligence. The combination of ultrafast DMD modulation, optical scattering and hierarchical reservoir dynamics opens new opportunities for real-time machine learning and next-generation photonic information processing systems.

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Fibonacci and Degenerate Conical Diffraction Cascades for Advanced Vector Beam Engineering

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Structured vector beams with spatially varying polarization distributions are attracting strong interest for applications in imaging, optical communications, polarimetry and beam shaping. Among the different generation approaches, conical diffraction (CD) in biaxial crystals provides a natural and efficient way to produce vector beams covering the equator of the Poincaré sphere [1,2]. In this work, we investigate theoretically advanced cascaded conical diffraction configurations [3,4] enabling extended polarization tailoring through path interference mechanisms.

We specifically analyze cascades of aligned biaxial crystals arranged according to Fibonacci and fully degenerate sequences. Using Berry's theoretical formalism for conical diffraction cascades, we demonstrate that properly engineered path interferences lead to complex concentric vector beam structures exhibiting spatially separated linear, elliptical and circular polarization states [5].

Our results reveal that Fibonacci cascades (figure 1) progressively increase the number of path interference and polarization diversity as the number of crystals increases, while fully degenerate cascades provide strong polarization complexity with a reduced number of crystals. Depending on the crystal arrangement and relative orientation angles, localized regions exhibiting nearly circular polarization can be selectively generated within the beam cross-section.

These cascaded architectures enable an extended exploration of the Poincaré sphere and provide versatile approaches for advanced vector beam engineering. The proposed configurations open promising perspectives for structured-light photonics, polarization multiplexing, optical trapping, spatially resolved polarimetry and photonic information processing.

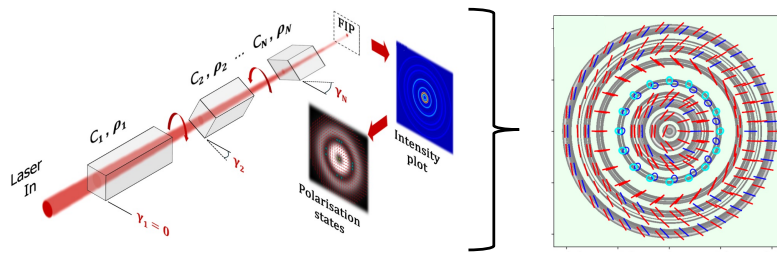


Figure 1 : Simulated polarization distributions generated by Fibonacci and/or fully degenerate conical diffraction cascades in various possible configurations (C_i, p_i, γ_i). On the right picture, we show an example of a generated vector beam in the case of a Fibonacci cascade where elliptical polarisation indicated by a red color corresponds to right-handed handiness and blue color to left-handed handiness. Cyan circles give regions where the polarization is circular.

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Sub-symmetry-protected compact edge states

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Symmetry-protected topological (SPT) phase is a pivotal concept in topological physics [1,2]. Recently, sub-symmetry (SubSy) protected topological states have emerged [3], expanding the common understanding of the SPT phases. In this study, boundary states are demonstrated to remain robust with only the SubSy preserved, rather than the full symmetry. Typical SPT and SubSy-protected boundary states decay exponentially into the bulk, which means they are not confined to just a few lattice sites close to the boundary. Here, we introduce topologically compact edge states protected by SubSy in an unbalanced cross-stitch-like lattice, featuring extreme two-site localization at the lattice boundaries, without any decay into the bulk. Unlike flat-band CLSs, these compact edge states do not rely on a flat band [4]. Instead, they are characterized by pertinent SubSy with a corresponding topologically nontrivial winding number. Experimentally, we observe the topological compact edge states in photonic lattices that feature SubSy. Lattice structures are established by using photorefractive effect in a photorefractive crystal (SBN:61) via a laser-writing technique [5]. Our results highlight the potential of SubSy protection for achieving topological confinement of light, paving the way for applications in compact waveguides, lasers, and high-sensitivity photonic sensors.

The left panel presents the theoretical analysis of SubSy-protected compact edge states. A schematic illustration of an unbalanced cross-stitch-like lattice is shown in (a), where t accounts for nearest-neighbor (NN) hopping and t_1 for the next-nearest-neighbor (NNN) hopping. The real-space eigenvalue spectrum as a function of t_1 is calculated for $t = 1$ [Fig. (b)], where the green line highlights compact edge states. When $t_1 = 0$, the system preserves chiral symmetry. When $t_1 \neq 0$, the global chiral symmetry is broken, while a SubSy is preserved. Figure (c) shows the calculated results for a SubSy lattice with $t_1 = 0.4$, where the left-edge state is protected by the preserved SubSy, while the right-edge state loses its symmetry protection. The right panel shows the experimental observations of topological compact states in a SubSy lattice. After 20 mm propagation, the probe beam matching the out-of-phase structure of the compact edge state remains well confined when launched at the left boundary. In contrast, under the same excitation conditions, light launched at the right boundary cannot remain confined to the initially excited sites due to the absence of SubSy protection.

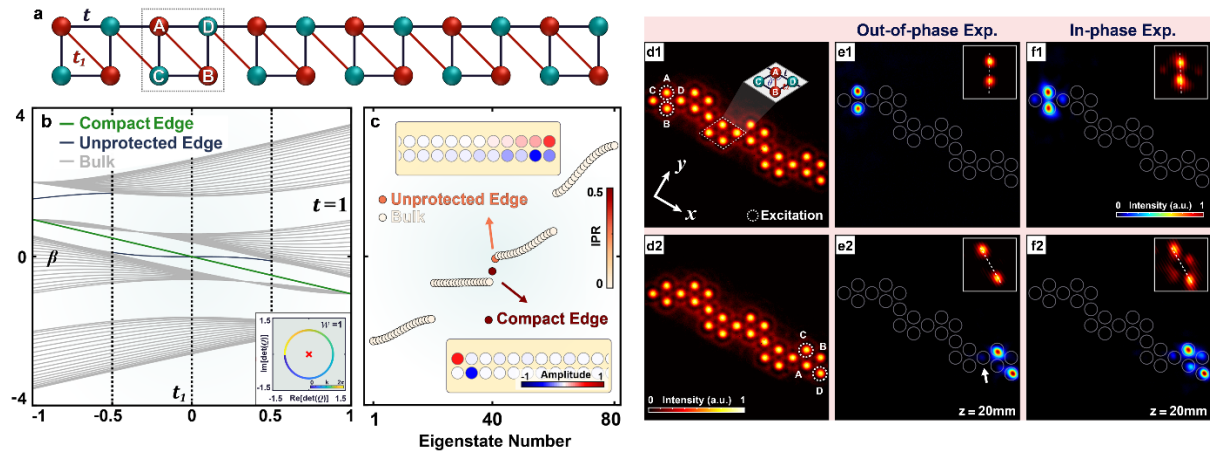


Figure – Theoretical analysis and experimental observations of SubSy-protected compact edge states.

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A Monolithic Active-Passive LNOI Photonic Integration Platform via Localized Thermal Diffusion

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Lithium niobate on insulator (LNOI) provides a low-loss, high-density, multifunctional material platform for integrated photonics^[1]. However, owing to its indirect bandgap, electroluminescence cannot be realized in undoped LNOI. While rare earth ion doping provides a gain medium for lithium niobate, but it also brings about non-negligible absorption losses^[2]. Here, a method for fabricating locally doped LNOI is introduced, and an active-passive LNOI platform is presented via localized Er^{3+} ions thermal diffusion. The concentration of Er^{3+} ions remains uniform at 0.3 mol% throughout the LN film. The intrinsic quality factors of microring resonators on active and passive regions are 2.64×10^5 and 7.48×10^5 , respectively. As a demonstration, an integrated amplifier-assisted microring laser is fabricated on this platform, which transmitted through the passive region before output, achieving a maximum slope efficiency of $4.09 \times 10^{-3}\%$ ^[3]. The monolithic active-passive LNOI photonic integration platform offers proven stability and compatibility, paving the way for advanced LNOI devices. It will undoubtedly promote the development and industrialization of LNOI integrated photonics.

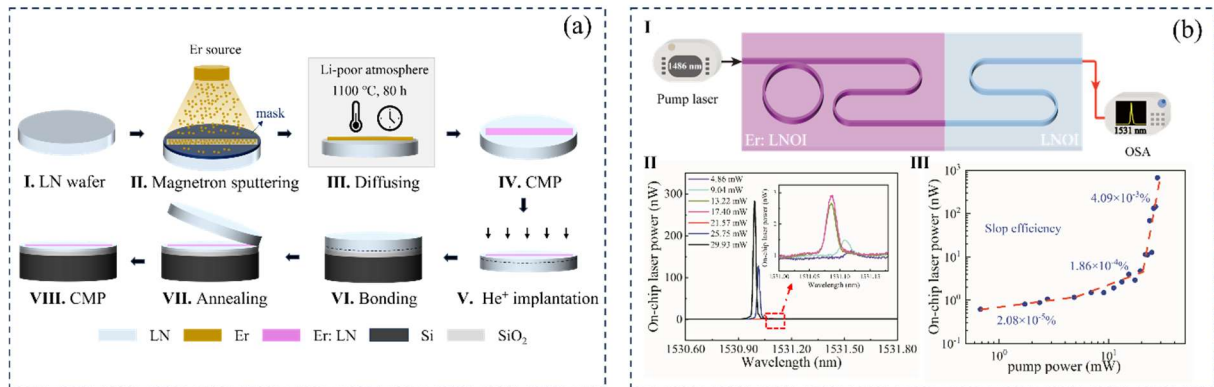


Figure – (a) Fabrication process of active-passive LNOI via localized thermal diffusion. (b) Structure and performance of the integrated amplifier-assisted microring laser. **I.** Experiment setup for the measurement of the amplifier-assisted microring laser, with the waveguide amplifier approximately 0.88 cm. **II.** Evolution of the collected photoluminescence spectra of the amplifier-assisted microring laser under varying pump powers. The inset displays a zoomed-in view of the highlighted rectangular area. **III.** Dependence of on-chip laser power of the dominant lasing mode on pump power.

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Temperature-Dependent Conductivity at Head-to-Head and Tail-to-Tail Domain Walls in Lithium Niobate Thin Films

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Conductive domain walls in lithium niobate have attracted considerable attention for enabling *n*-type and *p*-type conducting channels within an otherwise insulating crystal. Here, we fabricate head-to-head and tail-to-tail domain walls in MgO-doped and congruent x-cut lithium niobate thin films on insulator and investigate their temperature-dependent electrical conductivity from 20 to 160 °C. In both lithium niobate thin films, the two types of domain walls exhibit different conductivities, activation energies, and high-temperature behaviors: the head-to-head walls show thermally activated transport at low temperature followed by a pronounced conductivity suppression above 120 °C, whereas tail-to-tail walls retain a monotonic activated increase over the entire measured range. First-principles calculations reveal pronounced band bending at both charged walls, which shifts the relevant band-edge states toward the Fermi energy and enhances their conductivity. The resulting near-Fermi states are predominantly Nb-*d* electron-like at the head-to-head wall and O-*p* hole-like at the tail-to-tail wall. These spatially resolved density-of-states further reveals that the distinct activation energies of the two types of domain walls originate from the extended Nb-*d* electron-like states at head-to-head walls and the strongly localized O-*p* hole-like states at tail-to-tail walls.

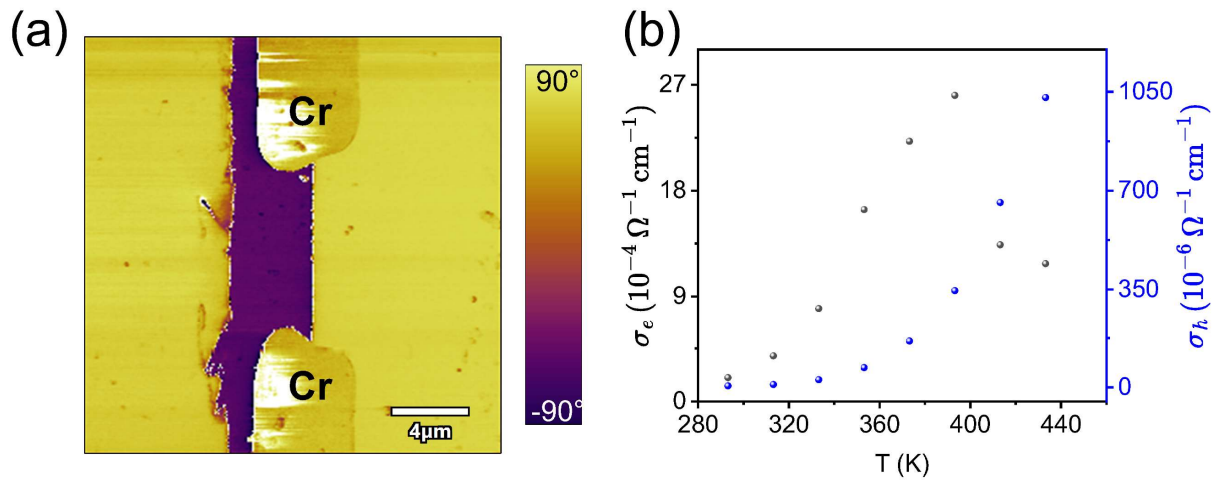


Figure1. (a) PFM phase image of domain wall in Lithium Niobate Thin Films. (b) Temperature dependence of the conductivity of head-to-head and tail-to-tail domain walls.

Compact Broadband Polarization-Insensitive Edge Coupler on SiCOI Based on Multi-Tip Subwavelength Gratings and Inverse Design

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Efficient fiber-to-chip coupling is essential for high-performance silicon carbide-on-insulator (SiCOI) photonic integrated circuits. However, existing edge couplers on the SiCOI platform still suffer from relatively high coupling loss, large device footprint, and strong polarization dependence. In this work, a compact, broadband, and polarization-insensitive SiCOI edge coupler is proposed and numerically demonstrated for the coupling between the lens fiber with a mode field diameter of 3 μm and the SiCOI waveguide. From the fiber to the chip, the device consists sequentially of a multi-tip subwavelength grating (SWG) taper, a duty-cycle-apodized SWG, and an inverse design structure. The structure parameters of the multi-tip SWG at the chip facet are optimized first through mode-overlap analysis to improve the mode field matching between the fiber mode and the mode of the multi-tip SWG. Then the grating taper and the apodized SWG are optimized by full-wave numerical simulations to reduce the spot-size of the mode. A 5- μm -long inverse-designed region is further introduced to efficiently convert and couple the optical field into the output waveguide with a 400-nm thick and 600-nm wide SiC film. Simulation results show that the proposed edge coupler has a total length of only 35.7 μm . At the wavelength of 1550 nm, the insertion losses for TE and TM modes are 0.356 dB and 0.457 dB, respectively, corresponding to a low polarization-dependent loss of 0.1 dB. In addition, the insertion losses of both polarizations remain below 1 dB over a bandwidth exceeding 200 nm, indicating excellent broadband and low-loss coupling performance. Misalignment tolerance analysis shows that an additional loss of approximately 1 dB is introduced when the lateral offset is larger than 1 μm or the vertical offset is about 0.2 μm , demonstrating good alignment tolerance. This design provides a feasible solution for efficient, compact, and polarization-insensitive on-chip optical interconnection on the SiCOI platform.

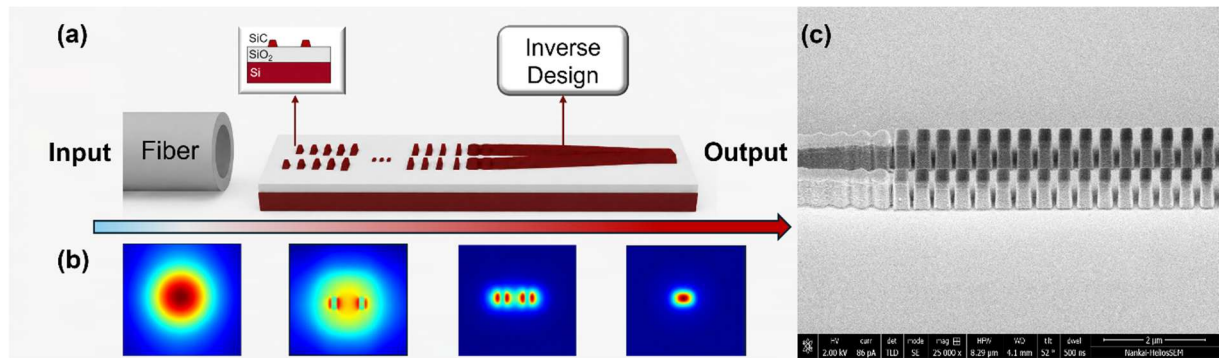


Figure 1 - Schematic diagram, mode evolution, and SEM image of the proposed SiCOI edge coupler. (a) Three-dimensional schematic diagram of the proposed SiCOI edge coupler based on multi-tip subwavelength gratings and inverse design. (b) Simulated optical mode evolution from the input fiber mode to the output waveguide mode. (c) SEM image of the fabricated subwavelength grating coupling region.

Direct writing of nanoscale periodic domain structures in lithium niobate thin films on silicon substrates

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It is well known that periodically poled lithium niobate (PPLN) is commonly used for nonlinear optics, while dot domains can be utilized for nonvolatile ferroelectric domain memories. PPLN with submicron period is crucial for spontaneous parametric down conversion (SPDC) and generation of GHz surface acoustic wave (SAW). Furthermore, submicron or even nanoscale domain means smaller devices and more refined structural design. In ferroelectric data storage, the size and spacing of dot domains determine the storage density. In our studies, we conducted experiments using two types of samples: one is z-cut congruent lithium niobate (CLN) thin films on low-resistance silicon substrates, and the other is z-cut lithium niobate thin films doped with 5.0 mol.% MgO ($\text{MgO}:\text{LiNbO}_3$) on low-resistance silicon substrates. To obtain lithium niobate thin films, we employed chemical mechanical polishing technique to reduce the thickness of lithium niobate from 10 μm to 20-350 nm. In the experiment, atomic force microscopy (AFM) with a bias electric voltage was employed for domain writing. The primary factors influencing the domain size in lithium niobate include the thickness of the lithium niobate thin films, the magnitude and the duration of the biased voltage during poling. By optimizing these parameters, we successfully fabricated PPLN with a period of 100 nm and dot domains with dimensions less than 50 nm in both congruent lithium niobate and MgO-doped lithium niobate. Moreover, these domains remained stable after three months of on-shelf storage.

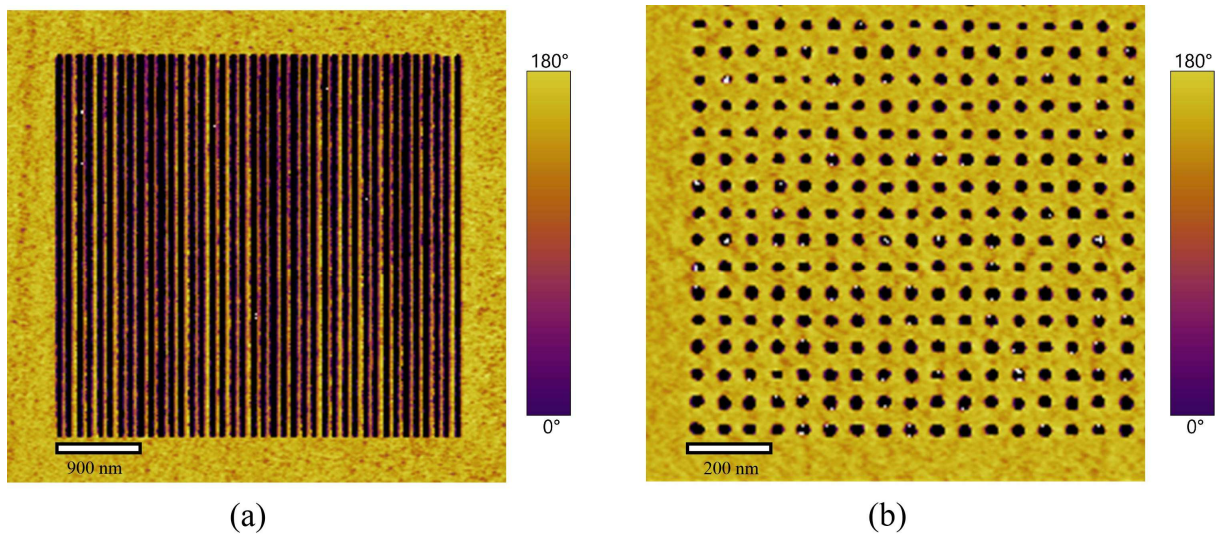


Figure 1. (a) PFM phase image of PPLN with a period of 100 nm fabricated in congruent lithium niobate. (b) PFM phase image of dot domains with dimensions less than 50 nm fabricated in MgO-doped lithium niobate.

Probing High-Temperature Sliding Ferroelectricity via Nonlinear Optical Spectroscopy

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Abstract

Sliding ferroelectrics constitute a distinct class of two-dimensional materials in which electric polarization originates from interlayer translation rather than ionic displacement [1]. Despite ultralow switching barriers, theoretical models have predicted remarkably high Curie temperatures for these systems [2,3], yet experimental verification under extreme thermal conditions has remained scarce. Here, we present direct evidence of an ultra-stable sliding ferroelectric phase in atomically thin 3R-MoS₂. Through temperature-dependent Raman spectroscopy, second-harmonic generation, and in-situ scanning transmission electron microscopy, we show that the rhombohedral stacking and concomitant inversion symmetry breaking are preserved up to 1000 K. Complementary in-situ transport measurements on dual-gate field-effect transistors confirm sustained switchable polarization up to 573 K, manifested as characteristic butterfly and rectangular hysteresis loops [4]. Ex-situ annealing at 1000 K followed by Kelvin probe force microscopy and photoluminescence mapping reveals persistent ferroelectric domain contrast. Molecular dynamics simulations attribute this exceptional thermal resilience to intrinsic symmetry protection and coherent interlayer sliding. Collectively, these findings establish 3R-MoS₂ as a benchmark system for high-temperature sliding ferroelectrics and highlight the efficacy of multi-modal optical, structural, and electrical probes for investigating phase stability in two-dimensional materials.

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A Compact Broadband Inverse-Designed Polarization Rotator on a 4H-SiC-on-Insulator Platform

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Efficient on-chip polarization control is essential for polarization-diverse and polarization-multiplexed photonic integrated circuits. In this work, we propose a compact inverse-designed polarization rotator on the 4H-SiC-on-insulator (4H-SiCOI) platform using topology optimization. Numerical results show that the polarization conversion performance varies with the sidewall angle. Among the investigated angles, the optimal performance is obtained at a sidewall angle of 81° , which is fabrication-friendly for 4H-SiCOI platform. The optimized device achieves efficient TM-to-TE polarization conversion. It can be fabricated via single-step etching without multi-step processing or air cladding — a feature advantageous for large-scale photonic integration. For a compact footprint of only $16\ \mu\text{m} \times 6\ \mu\text{m}$, the device achieves a polarization extinction ratio of 22.23 dB, a polarization conversion loss of 0.68 dB, and a polarization conversion efficiency of 99.40% at 1550 nm. Over a broad wavelength range of 1.50–1.62 μm , the polarization extinction ratio, the polarization conversion loss, and the polarization conversion efficiency are maintained at 19.82–29.69 dB, 0.56–1.01 dB, and 98.97%–99.89%, respectively. The proposed 4H-SiC polarization rotator features a fabrication-friendly design while simultaneously offering compact size, high conversion efficiency, low loss, and broadband operation, making it a promising building block for on-chip polarization management and SiC-based integrated photonic systems.



Figure - Topology-optimized TM-to-TE polarization rotator ($16\ \mu\text{m} \times 6\ \mu\text{m}$) on 4H-SiC-on-insulator.

Carrier-Dynamics-Mediated Ultrafast Control of Terahertz Harmonic Generation in Nonlinear Metasurfaces

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Abstract: Terahertz (THz) harmonic sources with ultrafast tunability are needed for adaptive spectroscopy, imaging, and high-speed communications, yet conventional nonlinear media exhibit weak room-temperature responses and limited dynamic control. Here we experimentally demonstrate an optically activated nonlinear THz metasurface based on gold split-ring resonators on an intrinsic GaAs substrate. Above-bandgap optical pumping at 800 nm generates free carriers in GaAs, while the resonant meta-atoms concentrate the incident THz field and drive nonlinear carrier motion. The Lorentz-force-induced transverse carrier response produces cross-polarized second-harmonic generation (SHG), whereas the enhanced local electric field in GaAs gives rise to co-polarized third-harmonic generation (THG). Without optical pumping, harmonic emission is strongly suppressed; under pumping, clear SHG and THG peaks appear at 1.6 and 2.4 THz, respectively, from a fundamental resonance near 0.8 THz. By varying the pump-THz delay, we achieve picosecond switching of both nonlinear channels, with characteristic times of 4.31 ps for SHG and 3.98 ps for THG and extinction ratios exceeding 10^3 . These results establish carrier-dynamics engineering in resonant metasurfaces as a compact route to room-temperature, reconfigurable THz frequency conversion and ultrafast nonlinear light-matter-interaction control.

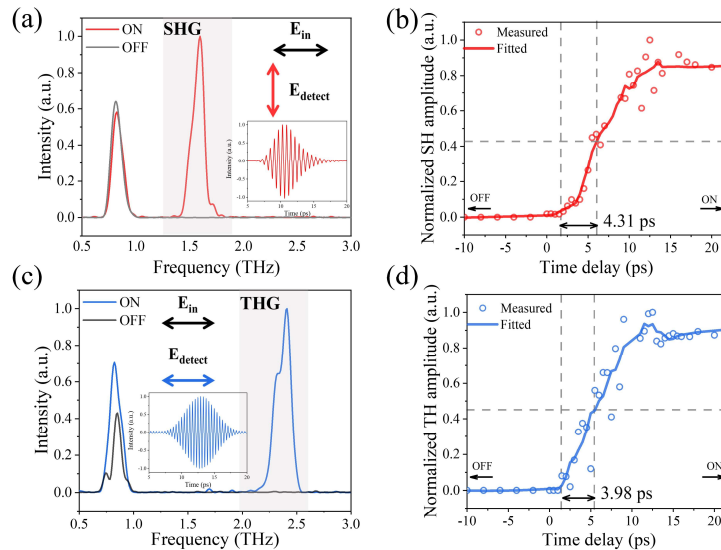


Figure 1. Optically activated SHG and THG spectra and their picosecond switching dynamics in the nonlinear THz metasurface.

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