

Outstanding Papers in 2025

[Design of multipass cell with dense spot patterns and its performance in a light-induced thermoelastic spectroscopy-based methane sensor](#)

Yufei Ma, Yahui Liu, Ying He, Shunda Qiao, Haiyue Sun

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Design of multipass cell with dense spot patterns and its performance in a light-induced thermoelastic spectroscopy-based methane sensor

Multipass cell (MPC) is a type of optical device used to increase the optical path length of gas absorption. It significantly increases the effective length of the laser-gas interaction in a small volume thereby enhancing the absorption signal. Yufei Ma and colleagues from Harbin Institute of Technology in China now report a mathematical model for MPC designing. Based on this model, they developed several MPCs with dense spot patterns and carried out sensor performance studies of them. A near-infrared methane LITES sensor based on a Raman fiber amplifier and a MPC with dense spot pattern was constructed, and excellent detection performance was achieved. This work is favorable to the development of high-sensitivity laser spectroscopy gas sensors, which is expected to bring new applications in areas such as industrial monitoring and fire warning.

[Ultrafast laser writing structural colors on TiAlN-TiN hybrid films](#)

Liping Shi, Panpan Niu, Qilin Jiang, Ji Yan, Jiao Geng

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Ultrafast laser writing structural colors on TiAlN-TiN hybrid films

Liping Shi from Xidian university and colleagues have unlocked a method to inscribe vibrant structural colors on TiAlN-TiN hybrid films via ultrafast laser direct writing. By meticulously controlling laser power, scanning speed, and pulse duration, they trigger surface oxidation, generating a broad spectrum of vivid colors. They found that while laser powers and scanning speeds are critical in determining the irradiated dose and the subsequent coloring effects, the pulse duration exerts a distinct influence, particularly at low laser powers as well as slow scanning speeds. This breakthrough not only refines the understanding of laser-induced surface coloration but also opens new avenues for anti-counterfeiting devices and the creation of advanced optical coatings, potentially influencing industries from security to automotive.

[Early detection of lithium battery leakage using a highly sensitive in situ ZIF-8 membrane-coated micro-nano optical fibre](#)

Shunfeng Sheng, Hao Li, Yi Zhang, Liangye Li, Kai Xiao, Xiukang Huang, Yunfei Liu, Wangyang Xu, Zhen Li, Lisong Yan, Zhijun Yan, Yunhui Huang, Qizhen Sun

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Early detection of lithium battery leakage using a highly sensitive in situ ZIF-8 membrane-coated micro-nano optical fibre

Detecting electrolyte leakage is an effective early warning approach for abnormal faults in lithium-ion batteries (LIBs) and can help mitigate safety risks such as fires and explosions. However, detecting electrolyte leakage in the early stages of LIB faults presents a significant challenge, as leaks in LIBs produce volatile organic compounds (VOCs) at parts per million levels that are difficult to detect using conventional VOC sensors. Here, an effective LIB VOC sensor using micro-nano optical fibres (MNFs) has been developed for the first time, coated with an in situ self-assembled zeolitic imidazolate framework-8 (ZIF-8) membrane as an electrolyte-sensitive layer. The

abundance of pores in ZIF-8 is excellent for adsorbing a variety of VOCs, including diethyl carbonate, ethyl methyl carbonate, dimethyl carbonate, and propylene carbonate. The MNFs possess high refractive index sensitivity, enhancing the online monitoring of electrolytes. MNFs with a diameter of approximately 7 μm were assembled with four-cycle ZIF-8 of approximately 500 nm thickness, as the fabricated sensor. Through wavelength demodulation, the LIB sensor demonstrated high sensitivity, detecting 43.6 pm/ppm of VOCs and exhibiting rapid response and recovery times of typically within 10 min and 23 s, respectively, as well as a low theoretical detection limit of 2.65 ppm for dimethyl carbonate vapor with excellent reversibility. The first on-site verification of online LIB leakage monitoring demonstrated that the sensor achieved a 35 h early warning prior to full-load leakage, thus exhibiting promising prospects for applications in scenarios such as car batteries.

[A Non-volatile Switchable Infrared Stealth Metafilm with GST](#)

Cong Quan, Song Gu, Tingzhao Fu, Ping Liu, Wei Xu, Chucai Guo, Zhihong Zhu, Jianfa Zhang

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A Non-volatile Switchable Infrared Stealth Metafilm with GST

A non-volatile switchable infrared stealth metafilm is experimentally demonstrated. The metafilm consists of high temperature resistant metal Molybdenum (Mo) and phase change material Ge₂Sb₂Te₅(GST). By controlling the phase state of GST, the switch between the infrared stealth and the non-stealth states can be realized. Specifically, when the GST is in the amorphous state, the emissivity in the 3-5 μm and 8-14 μm atmospheric window band is suppressed to realize infrared stealth, together with high emissivity in the non-atmospheric window band for radiative heat dissipation. While for the crystalline state of the GST, the average emissivity in the atmospheric window band is significantly improved, and the infrared stealth function cannot be realized. The metafilm will pave the way for the practical implementation of intelligent infrared stealth technology.

[3D-printed immersion micro optics](#)

Marco Wende, Kathrin Doth, Michael Heymann, Andrea Toulouse

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3D-printed immersion micro optics

High-performance 3D-printed micro optics for liquid immersion enable novel, cutting-edge applications in Life Sciences and photonic integrated technology. Femtosecond 3D-printing allows manufacturing of sophisticated micro optics with extremely flexible optical designs and diameters as small as a human hair. Available materials and manufacturing strategies, however, restricted their utility when immersed into liquids. A cross-disciplinary research group at the University of Stuttgart, Germany, developed a microfluidic sealing strategy for 3D-printed micro optics to protect critical optical surfaces from harmful contact with surrounding liquids. They demonstrate manufacturing of high-quality micro optics for operation in water-, silicone-, and oil-immersion. These immersed micro optics promise to advance miniaturized analytical devices for biomedical research, stable integrated circuit coupling, and keyhole-access medical endoscopy.

[Femtosecond laser fabrication of black quartz for infrared photodetection applications](#)

Raffaele De Palo, Annalisa Volpe, Pietro Patimisco, Andrea Zifarelli, Angelo Sampaolo, Antonio Ancona, Hongpeng Wu, Vincenzo Spagnolo

Light: Advanced Manufacturing. 2025, 6(4): 619-629. doi: [10.37188/lam.2025.026](https://doi.org/10.37188/lam.2025.026)

Femtosecond laser fabrication of black quartz for infrared photodetection applications

One of the big challenges in the field of photonics is the realization of a cost-effective, broadband and highly sensitive infrared photodetector, but many of the most recent and advanced solutions proposed for this aim achieve at maximum two of these requirements. Annalisa Volpe from Polytechnic University of Bari and colleagues propose Black Quartz as a new photoactive medium for broadband and efficient infrared photodetection. This material is easily obtained by superficial femtosecond laser texturing of quartz creating a new medium that has competitive responsivity in the 1 – 10 μm wavelength range. The authors provided proof of operativity of a black quartz photodetector in gas sensing setup by working at 1.39 μm and 7.38 μm with comparable results.

[Towards multi-dimensional atomic-level measurement: integrated heterodyne grating interferometer with zero dead-zone](#)

Can Cui, Lvye Gao, Pengbo Zhao, Menghan Yang, Lifu Liu, Yu Ma, Guangyao Huang, Shengtong Wang, Linbin Luo, Xinghui Li

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Towards multi-dimensional atomic-level measurement: integrated heterodyne grating interferometer with zero dead-zone

An integrated heterodyne grating interferometer offers multi-axis measurements with sub-nanometer, opening doors to precision engineering, microelectronics, and beyond. Driven by the need for atomic-level resolution in industry and research, Xing-Hui Li from China's Tsinghua University and colleagues now report an integrated three-dimensional heterodyne grating interferometer system. This system employs a dual-frequency light source and an innovative zero dead-zone optical path to eliminate measurement uncertainties. This advanced architecture ensures reliable performance despite fluctuations in light source frequency and environmental factors. In addition, this system adopts a robust crosstalk correction algorithm using wavelet transforms and Butterworth filtering, effectively reducing various crosstalk errors. The prototype demonstrates superior resolution, stability, and repeatability, marking a step forward for multi-dimensional atomic-level measurement across diverse fields.

[Overview of advanced optical manufacturing techniques applied in regulating laser damage precursors in nonlinear functional \$\text{KH}_x\text{D}_{2-x}\text{PO}_4\$ crystal](#)

Jian Cheng, Guang Chen, Mingjun Chen, Linjie Zhao, Qiao Xu, Xiaodong Yuan, Zhichao Liu, Shengfei Wang, Wei Liao, Qi Liu, Wenyu Ding, Longxiang Li

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Overview of advanced optical manufacturing techniques applied in regulating laser damage precursors in nonlinear functional $\text{KH}_x\text{D}_{2-x}\text{PO}_4$ crystal

Nonlinear $\text{KH}_x\text{D}_{2-x}\text{PO}_4$ crystals are key components in high energy/power laser systems, enabling frequency conversion and delivery of 1ω , 2ω , and 3ω lasers to achieve extreme fusion conditions. These systems demand ultra-precision, defect-free optics with meter-scale apertures to precisely control laser beams in time, space, and spectrum—posing significant manufacturing challenges. However, laser-induced damage initiated by micro-cracks, scratches, and debris from fabrication processes remains a bottleneck limiting energy output. To address this, advanced optical manufacturing techniques have been developed to suppress damage precursors and enhance laser resistance. Mingjun Chen and colleagues at Harbin Institute of Technology report state-of-the-art progress in regulating these precursors, discussing current challenges and practical solutions. This work provides valuable insights into performance-driven fabrication of $\text{KH}_x\text{D}_{2-x}\text{PO}_4$ optics and similar functional materials, supporting the advancement of high energy/power laser systems.