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Outstanding Papers in 2024

A multi-photon (7 × 7)-focus 3D laser printer based on a 3D-printed diffractive optical element and a 3D-printed multi-lens array

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New Generation of Multi-Focus 3D Laser Printing Allows for New Sample Dimensions

A new setup for highly-parallelized multi-focus 3D laser printing allows for print rates of 100 million voxels per second. This technology leap is based on a novel hybrid approach for efficient beam splitting using a diffractive optical element and a lens array for generating individual laser foci. Both elements have been manufactured by commercial two-photon grayscale lithography. The new capabilities are demonstrated by 3D printing a chiral metamaterial with more than 1 trillion voxels and millions of microparticles for potential pharmaceutical applications.

Meta-device: advanced manufacturing

Borui Leng, Yao Zhang, Din Ping Tsai, Shumin Xiao

Light: Advanced Manufacturing, 2024, **5**(1), 117-132**.** doi: 10.37188/lam.2024.005

Advanced Manufacturing for metasurface realization

The advanced nanofabrication technologies ensure the realization of metasurfaces. This paper provides an overview of state-of-the-art metasurface fabrication technologies, including maskless lithography, masked lithography, and other nanofabrication techniques. Din Ping Tsai from City University of Hong Kong, China, Shumin Xiao from Harbin Institute of Technology, China, and their colleagues review the recent achievements of nanofabrication techniques that are compatible with the manufacture of metasurfaces. Lithography with or without the mask and other nanofabrication techniques for metasurface are discussed. This article reviews serval well-fabricated metasurface works and summarizes the strengths and limitations of the nanofabrication techniques.

Adaptive multiscale microscope with fast zooming, extended working distance, and large field of view

Yi Zheng, Xin Wang, Zhao Jiang, Jinbo Xu, Rongying Yuan, Youran Zhao, Haoran Zhang, Chao Liu, Qionghua Wang

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Adaptive multiscale microscope with fast zooming, extended working distance, and large field of view

The field-of-view (FOV), depth of field, and resolution of conventional microscopes are constrained by each other; therefore, a zoom function is required. Traditional zoom methods lose real-time performance and have limited information throughput, severely limiting their application, especially in three-dimensional dynamic imaging and large-amount or large-size sample scanning. Here, an adaptive multiscale (AMS) imaging mechanism combining the benefits of liquid lenses and multiscale imaging techniques is proposed to realize the functions of fast zooming, wide working distance (WD) range and large FOV on a self-developed AMS microscope. The design principles were revealed. Moreover, a nonuniform-distortion-correction algorithm and a composite patching algorithm were designed to improve image quality. The continuous tunable magnification range of the AMS microscope is from 9× to 18×, with the corresponding FOV diameters and resolution ranging from 2.31 to 0.98 mm and from 161 to 287 line-pairs/mm, respectively. The extended WD range is 0.8 mm and the zoom response time is 38 ms. Experiments demonstrated the advantages of the proposed microscope in pathological sample scanning, thick-sample imaging, microfluidic process monitoring, and the observation of living microorganisms. The proposed microscope is the first step towards zoom multiscale imaging technology and is expected to be applied in life sciences, medical diagnosis, and industrial detection.

3D micro-devices for enhancing the lateral resolution in optical microscopy

Gordon Zyla, G. Maconi, A. Nolvi, Jan Marx, D. Ladika, Ari Salmi, V. Melissinaki, I. Kassamakov, Maria Farsari
Light: Advanced Manufacturing. 2024, ***5***(2), 204-217**.** doi: 10.37188/lam.2024.019

Laser-based 3D printing: A powerful tool to advance optical microscopy

Optical microscopy is a widely used technique across various multidisciplinary fields for inspecting objects, organisms, or surfaces at a small scale. However, its lateral resolution is fundamentally limited by the diffraction of light, a constraint that has become increasingly critical for its application as the demand for higher resolutions grows. Gordon Zyla from IESL/FORTH and colleagues have introduced an innovative solution to this issue. They have fabricated a micro-sphere using laser-based 3D printing, capable of significantly enhancing lateral resolution beyond the limits achievable with conventional optics. Combined with a novel and sophisticated printing strategy, the micro-sphere exhibited excellent geometric quality and perfect surface smoothness. The research team has incorporated the sphere into a 3D micro-device designed for flexible handling, which allows its integration into any optical microscope.

Dynamic 3D shape reconstruction under complex reflection and transmission conditions using multi-scale parallel single-pixel imaging

Zhoujie Wu, Haoran Wang, Feifei Chen, X. Li, Zhengdong Chen, Qican Zhang
Light: Advanced Manufacturing. 2024, **5**(3), 373-384**.** doi: 10.37188/lam.2024.034

Beyond point-to-point triangulation: Dynamic 3D reconstruction under complex reflection and transmission conditions

Depth measurement and three-dimensional (3D) imaging under complex reflection and transmission conditions are challenging and even impossible for traditional structured light techniques, owing to the precondition of point-to-point triangulation. Qi-Can Zhang from China's Sichuan University and colleagues now report a multi-scale parallel single-pixel imaging method that efficiently separates and utilizes different illumination and reflection components for dynamic depth measurement on multi-type surfaces and 3D imaging through complex transmission media, such as volumetric scattering media and semitransparent surface. The team demonstrated its effectiveness and results are promising for 3D imaging and sensing applications in advanced manufacturing, autonomous driving, and biomedical imaging.