亮点报道：基于神经元超表面的偏振模式复用信息加密方法

DOI: 10.12086/oee.2025.251011.h01

超表面凭借其对光波的精确调控能力和高度集成的结构，在全息显示、目标识别、图像分类等领域展现出颠覆性潜力。但现有的全息加密方法尚未充分发挥超表面的设计自由度，在信息存储密度和安全性能方面仍存在提升空间。

武汉大学电子信息学院郑国兴教授研究团队提出了一种面向高容量光学加密的双重维度复用全息显示方法，为构建高性能光学信息安全传输系统提供了全新思路。团队构建了一种 8 通道全息器件，采用尺寸变化的各向异性纳米结构，通过训练其在两个正交偏振方向上的相位分布，实现了对两组偏振模式的独立相位调控。其次，引入纳米结构的旋转角度作为新的可调参数，并联合训练超表面的旋角与相位分布，实现了对三组入射/出射偏振模式的复振幅调制，构建出支持三偏振与四模式复用的 12 通道全息器件。

该研究融合超表面、深度神经网络与光纤偏振模式复用等关键技术，提出了一种基于神经网络优化的偏振模式复用光学加密方法，显著提升了超表面在数据处理维度和信息传输密度方面的能力，具备高安全性、强扩展性和紧凑性，为智能超表面驱动的光学信息分类与加密应用开辟了新路径。

Intell Opto-Electron, 2025, **1**(1): 250001.
https://www.oejournal.org/article/doi/10.29026/ioe.2025.250001

Highlights: Polarized-mode multiplexed optical encryption based on neural metasurfaces

DOI: 10.12086/oee.2025.251011.h01

Metasurfaces have attracted significant attention in the field of optics due to their ability to achieve precise wavefront control and ultra-compact integration. Current holographic encryption techniques have not fully harnessed the design flexibility of metasurfaces, indicating potential for improvement in terms of information storage density and encryption security.

Prof. Guoxing Zheng's research group from the School of Electronic Information at Wuhan University has proposed a novel dual-dimensional multiplexing holography approach for high-capacity optical encryption, offering a promising paradigm for next-generation optical information security systems. The proposed approach employs a single-layer, non-interleaved neural metasurface optimized using deep neural networks to achieve coordinated multiplexing of polarization states and spatial modes. These parameters are treated as independent information channels, thereby significantly increasing the multiplexing dimensions and transmission capacity. To validate the feasibility and practicality of the approach, the team designed and fabricated two neural metasurface devices.

This work offers a new technical route for intelligent metasurface-enabled optical information classification and encryption. The research provides a foundation for future developments in high-capacity optical encryption systems and highlights the potential of combining artificial intelligence with photonic technologies for next-generation secure communication.

Intell Opto-Electron, 2025, **1**(1): 250001.
https://www.oejournal.org/article/doi/10.29026/ioe.2025.250001