亮点报道：声子辅助吸收的光电导开关——转化效率近 100%

DOI: 10.12086/oee.2026.261009.h01

传统光电导开关多依赖砷化镓等材料，但其击穿场强和高压工作能力有限，难以支撑高功率微波系统的小型化发展；新兴氧化镓基开关虽具备超宽禁带、高热稳定性等材料优势，但现有器件普遍采用杂质能级吸收的激发方式，存在电压转换效率低、导通损耗大的瓶颈，制约了工程化应用。

中山大学郑伟教授团队提出了基于声子辅助吸收的载流子激发新机制，成功研制出转化效率近 100% 的氧化镓光电导开关。文章原创提出并验证的声子辅助吸收光电导机制，通过声子耦合实现氧化镓晶体内部的高效载流子体激发，从底层载流子激发逻辑上突破了电压转换效率的瓶颈。

实验测试表明，该开关在 4000 V 偏置电压、1.98 mJ 激发能量下，峰值输出电压达 3957 V，电压转换效率高达 98.93%，接近理论极限；同时实现 17.7 MW/cm^2 的峰值输出功率密度，且在 50~4000 V 宽偏压范围内保持优异稳定性，输出电压相对偏差半高宽仅 3.01%。这一原创性设计不仅实现了当前报道中氧化镓光电导开关的最优综合性能，更打破了行业对超宽禁带半导体光电导器件激发方式的固有认知，为高功率微波系统向高效率、高功率密度和轻量化方向发展提供了全新的核心技术支撑。

Highlights: Phonon-assisted absorption photoconductive switch

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With the growth of the low-altitude economy, there is an urgent need for HPM security systems to counter drone threats. PCSSs are core components for miniaturized HPM systems, but conventional GaAs-based PCSSs are limited by low breakdown field strength. While gallium oxide (Ga_2O_3) offers an ultrawide bandgap and high thermal stability, existing devices rely on impurity-level absorption, causing high on-state loss and low efficiency.

Prof. Wei Zheng's team at Sun Yat-sen University, in collaboration with the Shanghai Institute of Optics and Fine Mechanics and the Shanghai Institute of Laser Plasma, proposed a photoconductive semiconductor switch based on a phonon-assisted absorption mechanism.

Testing showed that under a 4000 V bias, the device achieved a peak output voltage of 3957 V and a record voltage conversion efficiency of 98.93%, with a power density of 17.7 MW/cm^2. This original mechanism breaks the bottleneck of conventional excitation methods, providing key technical support for the development of efficient, high-power, and lightweight HPM systems for low-altitude security. This original design not only achieves the best comprehensive performance among currently reported Ga_2O_3 PCSSs, but also breaks the industry's inherent understanding of excitation methods for ultrawide-bandgap semiconductor PCSS devices, providing entirely new core technical support for the development of HPM systems toward high efficiency, high power density, and lightweight design, and laying a key device foundation for practical equipment development in low-altitude security and other key scenarios.

Opto-Electronic Science, 2026, **5**(5): 260011.
https://www.oejournal.org/article/doi/10.29026/oes.2026.260011
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