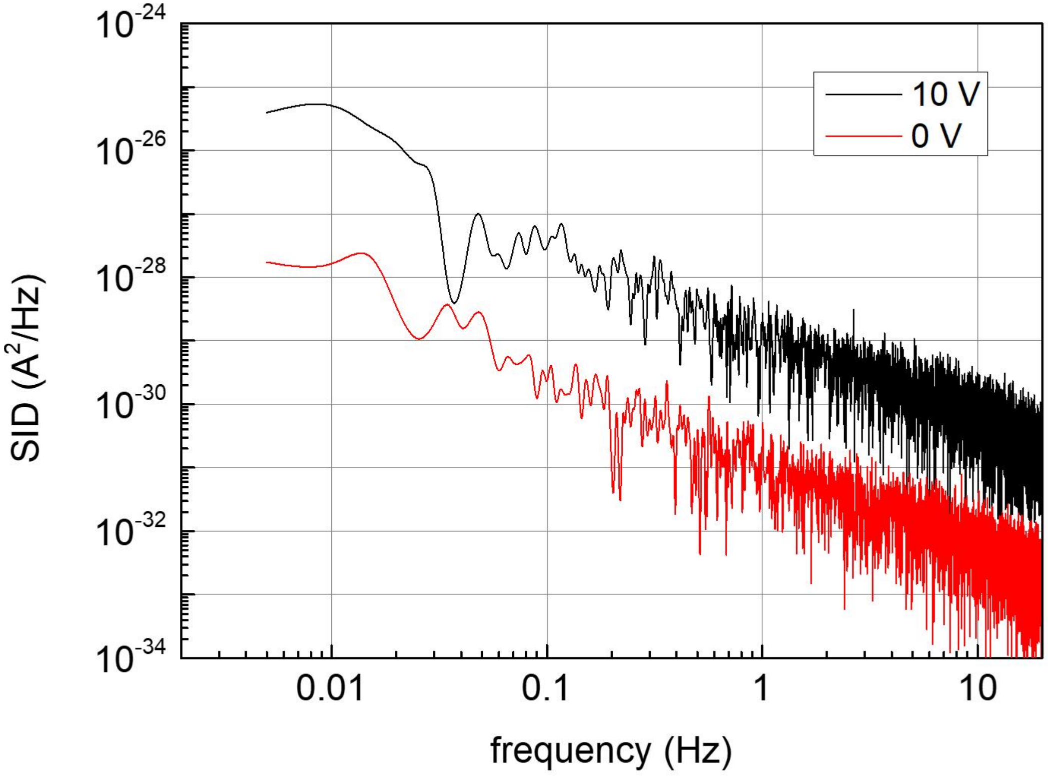
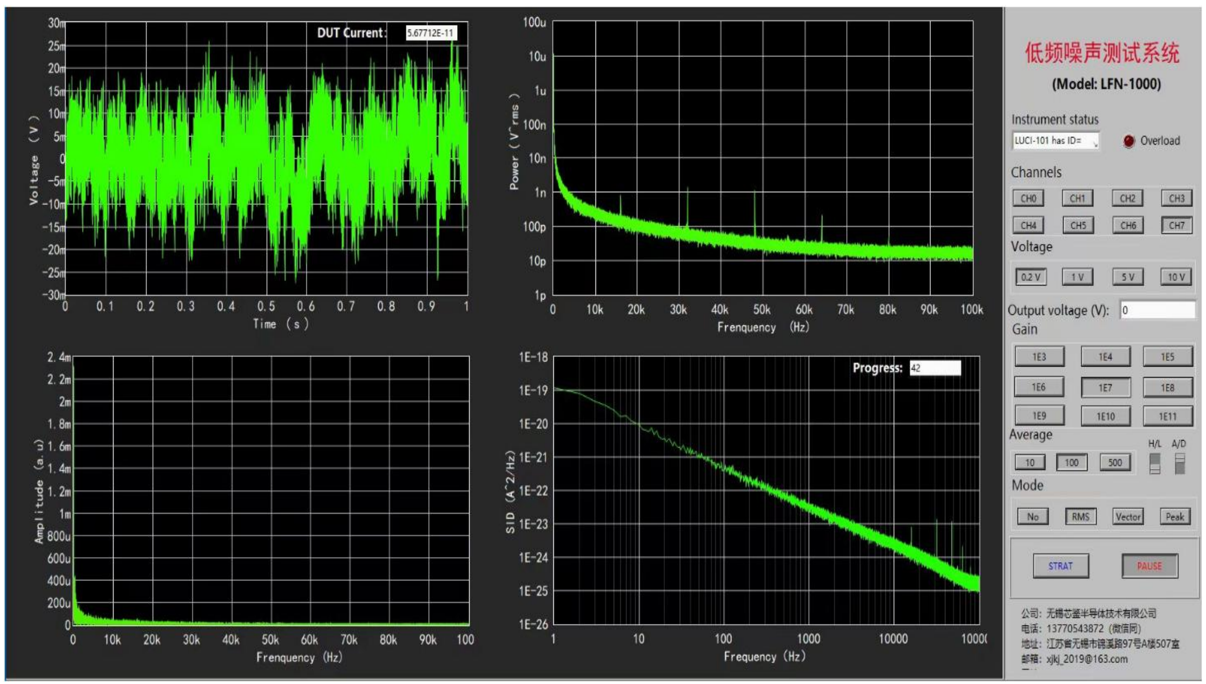


SLFN-2000

(Ultra)Low-Noise Test System

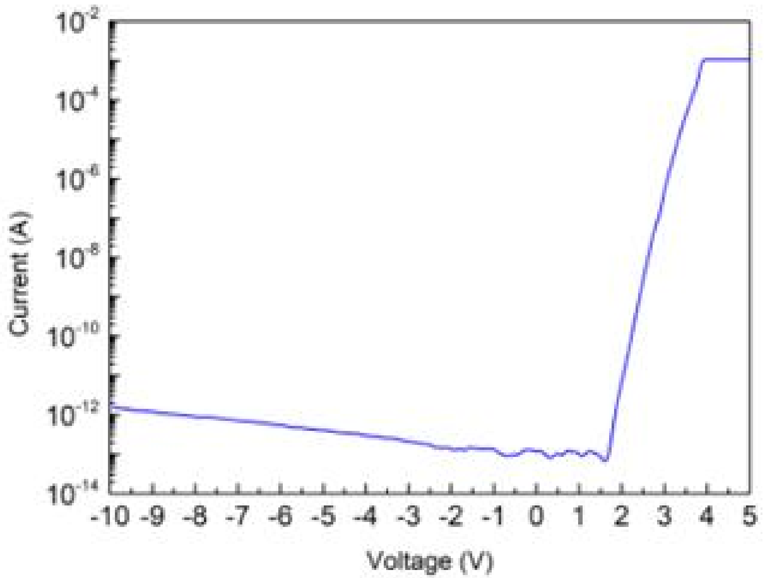
(Ultra)Low-Noise Test System

The SLFN-2000 is a highly cost-effective test system integrating low-frequency noise measurement, ultra-low-frequency noise measurement, IV scanning, and transient response measurement. It features a compact structure incorporating a micro-optical platform, low-noise current amplifier, spectrum analyzer, and optical microscope. Core modules utilize imported precision components to ensure exceptional measurement accuracy, achieving a noise floor as low as 10-28A2/Hz. Supporting both two-terminal and three-terminal testing, this system fulfills diverse testing requirements.



Interface

Product characteristic parameters



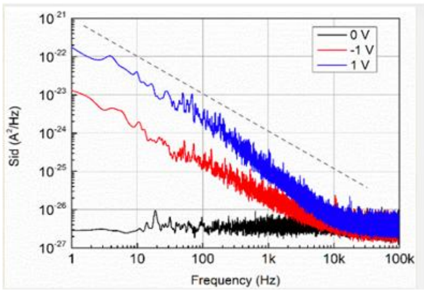
I-V Curve Scanning

- Bias Voltage Range：±10
- Current Resolution：<500fA 或 <1fA
- Frequency Range：0.1Hz-100KHz or 0.01Hz-10Hz
- Signal Output Range：0.2 V、1 V、5 V、10 V
- Current Amplification Factor：10^3-10^{11} or 10^5-10^{13}
- System Noise Floor：10^{-28} A^2/Hz(low frequency) or 10^{-32} A^2/Hz (ultra-low frequency)
- Data Averaging Modes：RMS、Vector、Peak

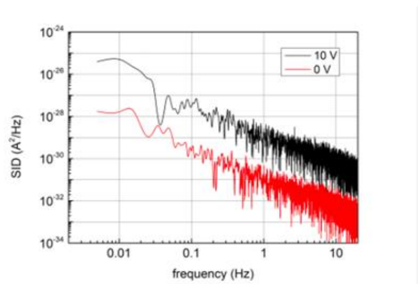
Product Features

- fA-level I-V Curve Scanning
- Noise floor:10^{-28} A^2/Hz或10^{-32} A^2/Hz
- Supporting both two-terminal and three-terminal testing
- Exceptional cost-performance ratio with integrated probe station
- User-friendly software interface with intuitive workflow
- Dynamic averaging with real-time visualization (up to 500 averages)
- Flexible data processing and one-click export

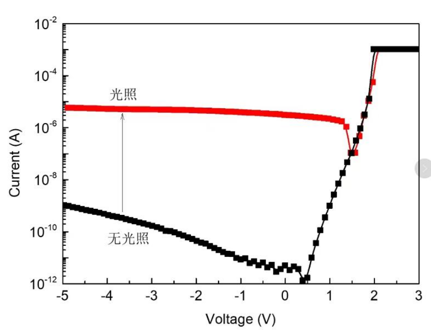
Application direction



Low frequency 1/f noise



Ultra-low frequency 1/f noise



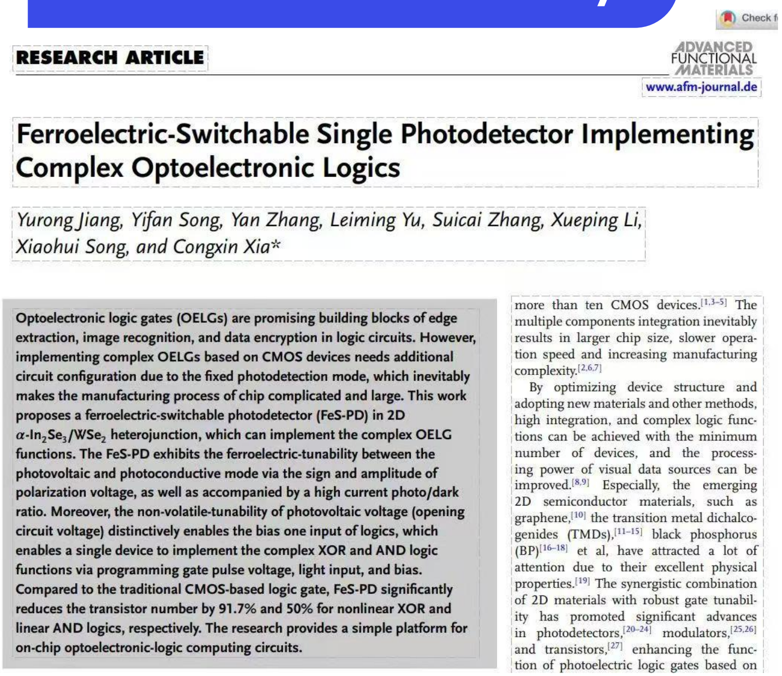
Photocurrent, dark current

- 1/f Noise Testing and Analysis
- RTN Testing and Characterization
- DC Current Measurement (500 fA resolution)
- Quantum Efficiency and Responsivity Characterization
- Optical Response Time (500 ns transient analysis)
- Reliability Non-Destructive Evaluation (NDE)
- Integrated Micro-Probe Station
- I-V (Current-Voltage) and I-T (Current-Time) Scanning
- Photocurrent and Dark Current Profiling

Application Cases

Currently, the SLFN-2000 (Ultra)Low-Frequency Noise Test System has been successfully deployed at multiple scientific institutions including: Changchun Institute of Applied Chemistry、Changchun University of Science and Technology、Nanjing University、Jiangnan University、Henan Normal University、Southwest University、Xiamen University.

Henan Normal University



RESEARCH ARTICLE

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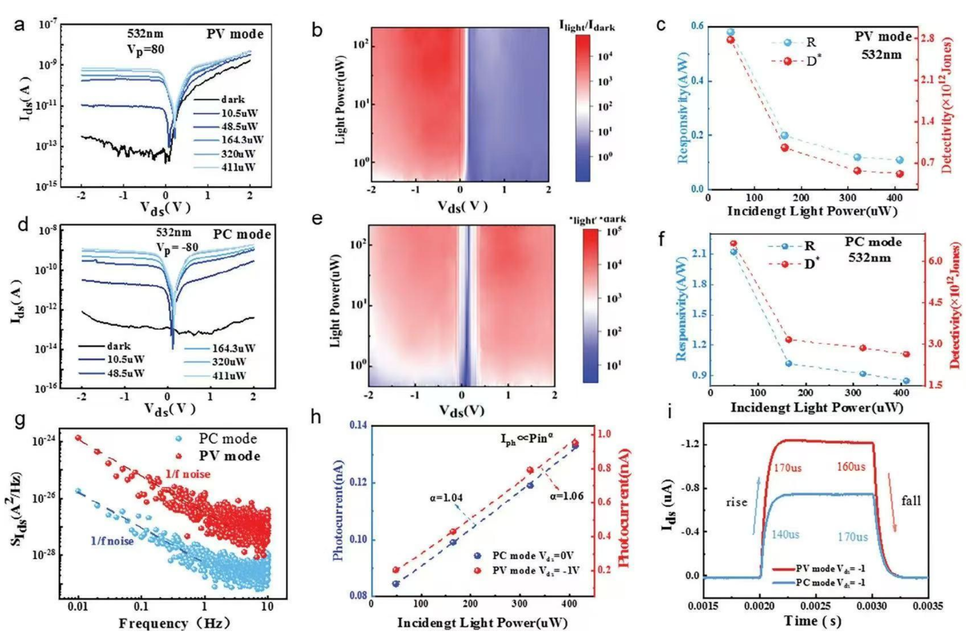
Ferroelectric-Switchable Single Photodetector Implementing Complex Optoelectronic Logics

*Yurong Jiang, Yifan Song, Yan Zhang, Leiming Yu, Suicai Zhang, Xueping Li, Xiaohui Song, and Congxin Xia**

Optoelectronic logic gates (OELGs) are promising building blocks of edge extraction, image recognition, and data encryption in logic circuits. However, implementing complex OELGs based on CMOS devices needs additional circuit configuration due to the fixed photodetection mode, which inevitably makes the manufacturing process of chip complicated and large. This work proposes a ferroelectric-switchable photodetector (FeS-PD) in 2D α-In_2Se_3/WSe_2 heterojunction, which can implement the complex OELG functions. The FeS-PD exhibits the ferroelectric-tunability between the photovoltaic and photoconductive mode via the sign and amplitude of polarization voltage, as well as accompanied by a high current photo/dark ratio. Moreover, the non-volatile-tunability of photovoltaic voltage (opening circuit voltage) distinctively enables the bias one input of logics, which enables a single device to implement the complex XOR and AND logic functions via programming gate pulse voltage, light input, and bias. Compared to the traditional CMOS-based logic gate, FeS-PD significantly reduces the transistor number by 91.7% and 50% for nonlinear XOR and linear AND logics, respectively. The research provides a simple platform for on-chip optoelectronic-logic computing circuits.

more than ten CMOS devices.[1,3–5] The multiple components integration inevitably results in larger chip size, slower operation speed and increasing manufacturing complexity.[2,6,7]

By optimizing device structure and adopting new materials and other methods, high integration, and complex logic functions can be achieved with the minimum number of devices, and the processing power of visual data sources can be improved.[8,9] Especially, the emerging 2D semiconductor materials, such as graphene,[10] the transition metal dichalcogenides (TMDs),[11–15] black phosphorus (BP)[16–18] et al, have attracted a lot of attention due to their excellent physical properties.[19] The synergistic combination of 2D materials with robust gate tunability has promoted significant advances in photodetectors,[20–24] modulators,[25,26] and transistors,[27] enhancing the function of photoelectric logic gates based on



Application Cases

Southwest University

RESEARCH ARTICLE

ADVANCED FUNCTIONAL MATERIALS
www.afm-journal.de

Unidirectional Bias-Switchable Dual-Mode Organic Photodetectors Enables Secure Communication and Gesture Simulation

*Haijun Jiang, Yuanhong Hu, Haohong Jiang, Tongzhou Wei, Ke Wang, Lixiang Chen, Qiaoming Zhang, and Yanlian Lei**

The development of dual-mode organic photodetectors (OPDs) greatly improves its functionality by enabling selective spectral detection. This study presents a unidirectional bias-switchable dual-mode OPD that leverages selective carrier extraction through the manipulation of light field distributions and non-equilibrium transport dynamics. This dual-mode OPD features a simple single-layer structure, allowing for straightforward one-sided light incidence and without the need for voltage polarity switching. By optimizing the blend of poly(4-butyl-phenyl-diphenyl-amine) and non-fullerene acceptor Y6, the device achieves efficient single-band detection of ultraviolet (UV) light at low bias and dual-band detection of UV and near-infrared light at high bias. This versatility not only streamlines device architecture but also facilitates secure optical communication and gesture simulation, making it a valuable tool for advancing organic optoelectronics. The proposed strategy demonstrates universal applicability, paving the way for enhanced security and functionality in digital communication systems.

1. Introduction

Organic photodetectors (OPDs) have attracted significant attention due to their unique advantages, including flexibility, cost-effective fabrication, and compatibility with various substrates.[1–5] Recent years have witnessed substantial advancements in the performance of OPDs, particularly in terms of sensitivity, response time, and spectral range.[6–14] However, traditional OPDs typically operate in a single mode, which restricts their applicability in complex communication scenarios.[15–17] The development of dual-mode operation—where a single device can respond to multiple spectral bands—offers a promising approach to enhance the functionality of OPDs.

State-of-the-art strategies for dual-mode OPDs typically involve the vertical stacking of photosensitive layers, such as heterojunctions or single semiconductor arrangements.[18–25] These designs leverage layers with distinct spectral response bands, allowing for independent readout and enabling dual-mode functionality within a single device. However, they often require polarity changes in external voltages for band switching, as demonstrated in our previous work,[18] where photocurrent is generated in different layers under forward and reverse bias conditions, thereby increasing operational complexity. Additionally, the vertical stacking of multiple photosensitive layers poses significant challenges, particularly when employing cost-effective solution-processing techniques, as achieving solvent orthogonality among materials with similar molecular structures complicates the fabrication process.

An alternative approach is the development of bidirectional dual-mode OPDs, which can exhibit photoresponse in two distinct spectral bands depending on the illumination side.[26–29] This design facilitates the detection of multiple bands without the need to switch bias polarity. However, the requirement for a transparent top electrode complicates fabrication due to issues related to spectral matching and interface contact in two-sided incident architectures.[30] Therefore, a unidirectional bias-switchable dual-mode photodetector with a simplified structure and one-sided illumination is more desirable. To date, unfortunately, such devices have been scarcely reported.

In this study, we developed a unidirectional bias-switchable dual-mode OPD based on a simple single-layer light-absorbing unit. By manipulating carrier extraction dynamics within a poly-TPD: Y6 blended single-layer, comprising poly(4-butyl-phenyl-diphenyl-amine) and a non-fullerene acceptor (Y6), we achieved spectral-selective detection, enabling ultraviolet (UV) single-band detection at low bias and UV/near-infrared (NIR) dual-band detection at high bias. This capability allows the device to process and separate mixed light signals. We propose an encrypted optical communication application using UV and NIR light, where mixed information is received at high bias and key data at low bias. The device also supports five current levels for gesture

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DOI: 10.1002/adfm.202419686

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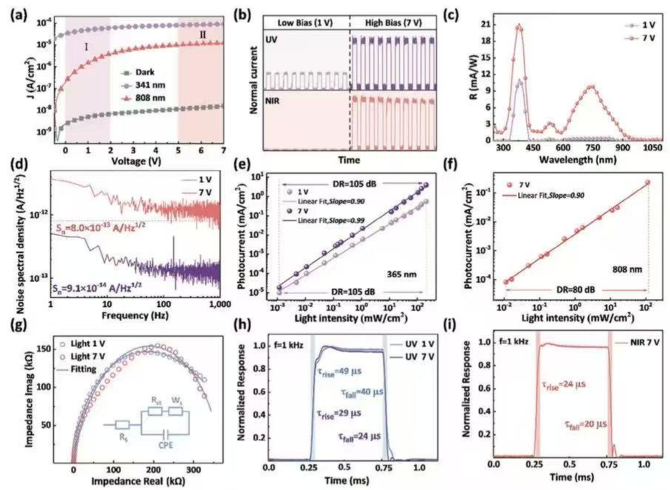

Figure 3. Dual-mode photoresponse characteristics. a) *J–V* curves of the dual-band OPD in the dark and under UV (341 nm) and NIR (808 nm) illumination at an intensity of 1.6 mW cm^{-2}. b) Current–time response curves of the device under low and high bias conditions. c) Responsivity as a function of wavelength d) Noise spectral density of the device at low and high bias. Dynamic range characteristics under the illumination of e) UV (365 nm) and f) NIR (808 nm) light. g) Impedance spectra of the device under white light illumination at 1 and 7 V. Time-resolved photoresponses under h) UV and i) NIR light illumination.

the photocurrent. However, the low concentration of Y6 (poly-TPD:Y6 = 8:1) limits the formation of an independent transport channel, requiring photogenerated carriers to transfer to poly-TPD for conduction, leading to losses through non-radiative recombination. Consequently, the photocurrent from NIR irradiation is minimal compared to that from UV irradiation at low bias (1–2 V). As the voltage increases, exciton dissociation and charge transport improve, enhancing carrier collection near and far from the interface, thus increasing the overall photocurrent. The photocurrent ratio under UV and NIR irradiation exceeded 10^2 at 0 V but sharply decreased to ≈7 at 7 V. This enables unidirectional bias-switchable dual-mode detection by leveraging the differences in photoresponses to UV and NIR light.

Figure 3b shows the steady photocurrent-time curves under pulsed illumination at 341 nm (UV) and 808 nm (NIR), assessing the output current signals produced by this device. A notable disparity in photoresponse is observed depending on the bias voltage for UV and NIR light. At a low bias of 1 V, the device generates clear and stable photocurrent signals when exposed to UV light, while the response to NIR light is minimal. In contrast, at a high bias of 7 V, the device effectively produces repeatable, high-current signals in response to both UV and NIR irradiation. This behavior is evident in the device's responsivity and external quantum efficiency (EQE) (Figure 3c; Figure S5, Supporting Information). At low bias (1 V), the device shows a narrow single-band UV response due to the narrow-band UV absorption of poly-TPD (Figure 1b), achieving a maximum responsivity of ≈11.3 mA W^{-1} with a full width at half maximum of 47 nm, while the NIR photoresponse remains negligible. This limited NIR response is attributed to the poor electron mobility and low electric field intensity, which hinder the extraction of photogenerated carriers from Y6. As previously discussed, increasing the electric field strength enhances the extraction efficiency of photogenerated carriers in both poly-TPD (under UV light) and Y6 (under NIR light). Consequently, as bias voltage increases, both responsivity and EQE improve, particularly in the NIR range. At 7 V, the device demonstrates efficient dual-band responses, with maximum responsivities of 21.3 mA W^{-1} for UV and 10.0 mA W^{-1} for

Application Cases

Nanjing University

IEEE TRANSACTIONS ON ELECTRON DEVICES

X-Ray Irradiation-Induced V_{TH} Instability in Schottky-Gate p-GaN HEMTs

Yu Rong, Feng Zhou, *Member, IEEE*, Wenfeng Wang, Can Zou, Junfan Qian, Weizong Xu, Fangfang Ren, Dong Zhou, Dunjun Chen, Youdou Zheng, Rong Zhang, and Hai Lu, *Senior Member, IEEE*

***Abstract*—p-GaN Schottky-gate structure E-mode HEMTs have great potential for irradiation applications, yet their threshold voltage (V_{TH}) instability is still under investigation. In this work, by constructing an X-ray irradiation online monitoring system with adjustable dose and integrated peripheral bias circuit, irradiation dose- and drain bias-dependent V_{TH} instability are comprehensively investigated. Under irradiation-only conditions, the device exhibits a negative V_{TH} shift with low-dose irradiation, followed by a positive V_{TH} shift with high-dose irradiation. By performing numerical simulations, Hall measurements, and *C–V* tests, it is revealed that the negative V_{TH} shift is dominated by the p-GaN activation-induced V_{TH} instability mechanism, rather than the gate-related hole injection mechanism. The corresponding activation efficiency of p-GaN increases from 1.3% (unirradiated device) to 1.5% (0.11-Sv irradiation). Furthermore, acceptor-like defects are identified as the main cause of positive V_{TH} shift. The low-frequency 1/*f* noise experimental results show that the density of defect states at different doses is higher than that of unirradiated devices. Moreover, under the synergistic effect of irradiation and drain bias, the device still exhibits a positive V_{TH} shift, which can be explained by the modified charge storage mechanism. These results provide important insights into the V_{TH} instability of p-GaN Schottky-gate structure high electron mobility transistors (p-GaN HEMTs) under irradiation conditions.**

***Index Terms*—Defect formation, Hall measurement, p-GaN activation, p-GaN Schottky-gate structure high electron mobility transistor (p-GaN HEMT), V_{TH} instability, X-ray irradiation.**

I. Introduction

P-GaN Schottky-gate structure high electron mobility transistors (p-GaN HEMTs) have been widely used in consumer electronics such as fast charging in recent years, and also have great potential in irradiation electronic applications [1], [2], [3]. A notable advantage of p-GaN HEMTs

Received 28 November 2024; revised 22 January 2025; accepted 20 February 2025. This work was supported in part by the Science and Technology Innovation Key Research and Development Program of Chongqing under Grant CSTB2024TIAD-STX0007, in part by the National Natural Science Foundation of China under Grant 62304102 and Grant 62374084, and in part by Jiangsu Provincial Key Research and Development Program under Grant BE2023007-4 and Grant BK20232045. The review of this article was arranged by Editor M. Meneghini. *(Corresponding authors: Feng Zhou; Hai Lu.)*

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Digital Object Identifier 10.1109/TED.2025.3545390

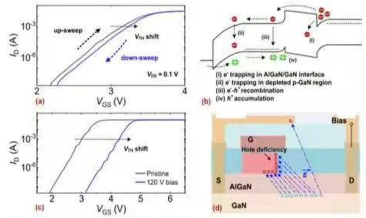

Fig. 1. (a) Transfer curve of p-GaN HEMT and (b) electron trappi effect. (c) Drain bias-induced positive V_{TH} shift and (d) charge storag mechanism.

compared to MIS HEMTs is that the gate-oxide-free p-Ga heterojunction is less susceptible to total ionizing dose (TII irradiation effect [4], [5]. However, the "floating p-GaN sandwiched between the gate metal and the channel ca cause threshold voltage (V_{TH}) instability [6], [7], [8], [9 [10]. In particular, V_{TH} hysteresis (mainly positive shift) the transfer characteristic [Fig. 1(a)] [7], [8], and OFF-sta drain bias-induced positive V_{TH} shift [Fig. 1(c)] [6], [10] hav been widely reported. The former is generally attributed the electron trapping effect [i.e., trapping in depleted p-Ga region and AlGaN/GaN interface, Fig. 1(b)] [7], [9], while th latter is believed to be the accumulation of net negative charge in p-GaN due to charge storage mechanism or hole deficienc [Fig. 1(d)] [6], [10]. Under irradiation conditions, V_{TH} shi behavior of p-GaN gate HEMTs should be more complex ar elusive.

A key obstacle limiting research progress is that conductin irradiation experiments is cumbersome and inconvenient [11 requiring site-specific facilities such as cobalt-60 gamm source [3] and heavy ion accelerator [12]. Consequently, th V_{TH} instability of p-GaN HEMTs remains underexplored. Ve recently, after the irradiation experiments are completed, th TID-induced V_{TH} characteristics under dynamic bias stre are investigated [13], revealing the hole injection and electro trapping mechanisms. Earlier research on GaN materials [14 [15] found that the hole concentration (n_{hole}) of p-GaN itse will change under irradiation-only condition. Therefore, it crucial to first elucidate the V_{TH} instability of p-GaN structur devices under irradiation-only conditions, and online monito ing of V_{TH} is preferred to improve test accuracy.