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超快激光转移制备可穿戴 GaN 心率监测光子微芯片

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随着社会的发展和全球人口老龄化趋势的越发严重，心脏疾病已成为威胁老龄化人群健康的头等病因，可穿戴持续心率监测设备更有助于对人体心脏疾病的预防及诊断。然而，可穿戴心率监测设备由于其极高的制备技术壁垒，目前仍无法保证监测精度且难以微型化。

本文介绍了采用超快激光转移技术制备微型柔性 GaN 心率监测光芯片的研究工作。该技术以入射高能紫外光子诱导材料电离，通过超快非线性效应对分离层电离态的调控，使 GaN 光子芯片底层材料产生温和的解离并形成 5 nm 尺度的超平坦界面空腔，使厚度仅为 10 μm，尺寸不足百微米的 GaN 光子芯片与其原始衬底进行可控分层，从而实现其与异质柔性衬底的匹配集成。集成后的柔性 GaN 光子芯片既能作为监测光源，又可对人体血管反射回的光容积扫描（PPG）信号进行接收。接收到的 PPG 信号通过算法识别，实现人体心率的动态监测以及初步诊断。这种高效灵活的激光转移微型芯片制备技术除了用于柔性 GaN 光芯片的制备，还可以用于多种传统电子器件的柔性化制作，对于未来可穿戴电子器件的高度集成化提供了一条可行的研发之路。

关键词：超快激光转移；可穿戴电子；GaN 光子芯片；心率监测；光容积扫描法

参考文献

[1] Weigao Sun, Lingfei Ji, Zhenyuan Lin, Jincan Zheng, Zhiyong Wang, Litian Zhang, and Tianyang Yan. Low-energy UV ultrafast laser controlled lift-off for high-quality flexible GaN-based device, *Adv. Funct. Mater.*, **2022**, **32(8)**: 2111920.

[2] Tianyang Yan, Lingfei Ji, Weigao Sun. Characteristics and formation mechanism of filamentary plasma string induced by single picosecond laser pulse in sapphire. *Appl. Phys. A*, **2022, 128(1)**: 39.

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Ultrafast laser transfer fabrication of wearable GaN heart pulse monitoring photonic microchips

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With the development of society and the aging trend of the global population, heart disease has become the first cause of threatening the health of the aging population. Wearable continuous heart pulse monitoring device is more helpful for the prevention and diagnosis of human heart disease. However, the wearable heart pulse monitoring devices are still not guaranteed to be accurate and difficult to miniaturize due to the high technical barriers to their manufacture.

This paper presents the research work on the fabrication of miniature flexible GaN heart pulse monitoring photonic chips by ultrafast laser transfer technique. This technique induces material ionization by incident high-energy UV photons, and controls the ionization state of the separated layer through ultrafast non-linear effects, so that the underlying material of the GaN photonic chip is gently decomposition and an ultra-flat interface cavity with a scale of 5 nm is formed. The GaN photonic chip with a thickness of only 10 μm and a size of less than 100 μm is controlled by delamination from its original substrate, thereby realizing its matching integration with a heterogeneous flexible substrate. The integrated flexible GaN photonic chip can not only serve as a monitoring light source, but also receive the photoplethysmography (PPG) signal reflected back from human blood vessels. The received PPG signal is identified by an algorithm to enable dynamic monitoring of the human heart rate and initial diagnosis. In addition to the fabrication of flexible GaN photonic chips, this efficient and flexible laser-transfer microchip fabrication technology can also be used in the flexible fabrication of a variety of conventional electronic devices, providing a viable R&D path for the highly integrated wearable electronics of the future. This work was supported by National Natural Science Foundation of China (51975017) and Scientific Research Key Program of Beijing Municipal Commission of Education (KZ202110005012).

Keywords: Ultrafast laser transfer; Wearable electronics; GaN photonic chip; Heart pulse monitoring; Photoplethysmography

References:

[1] Weigao Sun, Lingfei Ji, Zhenyuan Lin, Jincan Zheng, Zhiyong Wang, Litian Zhang, and Tianyang Yan. Low-energy UV ultrafast laser controlled lift-off for high-quality flexible GaN-based device, *Adv. Funct. Mater.*, **2022**, **32(8)**: 2111920.

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