High-performance Micro-Size Light-Emitting and Detecting Diodes with Triangular shapes

Huabin Yu[1], Muhammad Hunain Memon[1], Haiding Sun[1]
[1] School of Microelectronics, University of Science and Technology of China, Anhui 230026, China.

Introductions

Reducing the chip size of optoelectronic devices, such as light-emitting diodes (LEDs) and photodetectors (PDs), to the micrometer scale is a crucial technological frontier [1]. However, the development of monolithically integrated active devices, such as micro-LEDs and micro-PDs, is still in early stages due to the limited device performance [2, 3]. Herein, we proposed a triangular-shaped micro-sized diode (T-μ-diode) to enhance DUV emission and detection performance of the devices.

Methods

The epitaxial structures of the samples, as shown in Fig. 1a. Figures 1b and 1c show the schematics of the T-μ-diode and circular-shaped micro-sized diode (C-μ-diode). Both types of devices have the same chip size. Figure 1d displays the optical microscope images of devices.

Results

As illustrated in Figs. 1e and 1h, both the T-μ-diodes and C-μ-diode exhibit emission peaks and detection peaks within the deep ultraviolet (DUV) region. Notably, the T-μ-diodes outperform the C-μ-diodes, showcasing superior light output power with a -3 dB modulation bandwidth exceeding 566 MHz, as depicted in Figs. 1f, 1g. Furthermore, the T-μ-diodes exhibit a higher photo-responsivity of approximately 160 mA/W, coupled with a faster response speed of 3.1 ns in Figs. 1i, and 1j. This achievement is facilitated by switching the operation mode of two T-μ-diodes monolithically fabricated on the same platform, as highlighted in Fig. 1k-m.

Conclusion

We demonstrate that triangular-shaped microsize diodes outperform their circular-shaped counterparts with higher performance. Such improvement makes them promising for various applications, especially in the construction of on-chip and free-space solar-blind optical communication systems.