Supporting Information

In-situ Preparation Bi$_2$O$_2$Se/MoO$_3$ Thin-Film Heterojunction Flexibility Array Photodetectors

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Figure S1. Schematic diagram of the fabrication process of $\text{Bi}_2\text{O}_2\text{Se}/\text{MoO}_3$ composite thin film and device by two-step thermal deposition method.

Figure S2. Optical image of $\text{Bi}_2\text{O}_2\text{Se}/\text{MoO}_3$ thin film array heterojunction device on mica.
**Figure S3.** Cross section SEM image of the fabricated Bi$_2$O$_2$Se/MoO$_3$ thin film heterojunction device.

**Figure S4.** The EDS cross section element mapping image of the fabricated Bi$_2$O$_2$Se/MoO$_3$ thin film heterojunction device.
Figure S5. The SEM image (a) and EDS pattern (b) of Bi$_2$O$_2$Se/MoO$_3$ heterostructure.

Figure S6. Absorption curves of Bi$_2$O$_2$Se/MoO$_3$ and Bi$_2$O$_2$Se thin films from 300 nm to 1400 nm.
**Figure S7.** (a) The $\text{Bi}_2\text{O}_2\text{Se}/\text{MoO}_3$ thin films heterojunction device structure simulate diagram of SILVACO TCAD software. (b) The holes density diagram of $\text{Bi}_2\text{O}_2\text{Se}/\text{MoO}_3$ thin films heterojunction device by SILVACO TCAD software simulate @ 808 nm irradiation with different power intensity.

**Figure S8.** The holes distribution density diagram of $\text{Bi}_2\text{O}_2\text{Se}/\text{MoO}_3$ thin films heterojunction device by SILVACO TCAD software simulate under 808 nm irradiation with different power intensity (a) P1, (b) P3, (c) P2 and (d) P4. Among P4 > P3 > P2 > P1.
Figure S8. The holes distribution density diagram of Bi$_2$O$_2$Se/MoO$_3$ thin films heterojunction device by SILVACO TCAD software simulate under $V_{ds} > 0$ V with different waveband light irradiation (a) 520 nm, (b) 808 nm, (c) 980 nm and (d) 1550 nm. (e), (f) Current and holes distribution density curves of Bi$_2$O$_2$Se/MoO$_3$ thin films heterojunction device.

Figure S10. The band contact diagram of Bi$_2$O$_2$Se and MoO$_3$ materials under (a) $V_{ds} < 0$ V, (b) $V_{ds} = 0$ V and (c) $V_{ds} > 0$ V according to the band characteristics.
Figure S11. $I_{ph}$ of Bi$_2$O$_2$Se/MoO$_3$ device @ 808 nm under different power densities.

Figure S12. $R_i$ and current curves of Bi$_2$O$_2$Se/MoO$_3$ device at different laser power intensity.
Figure S13. $\tau_{on}$ and $\tau_{off}$ of the Bi$_2$O$_3$Se/MoO$_3$ heterojunction photodetector (a) @ 650 nm and (b) @ 980 nm. The $\tau_{on}$ and $\tau_{off}$ of device @ 650 nm and @ 980 nm were less than 180 and 180 µs, 300 and 500 µs, respectively.

Figure S14. The noise diagram of pure Bi$_2$O$_3$Se thin film device and Bi$_2$O$_3$Se/MoO$_3$ thin film heterojunction device.
Figure S15. The relationship between the $R_i$ and $D^*$ of the Bi$_2$O$_2$Se/MoO$_3$ thin film heterojunction device and the laser power density changes.