

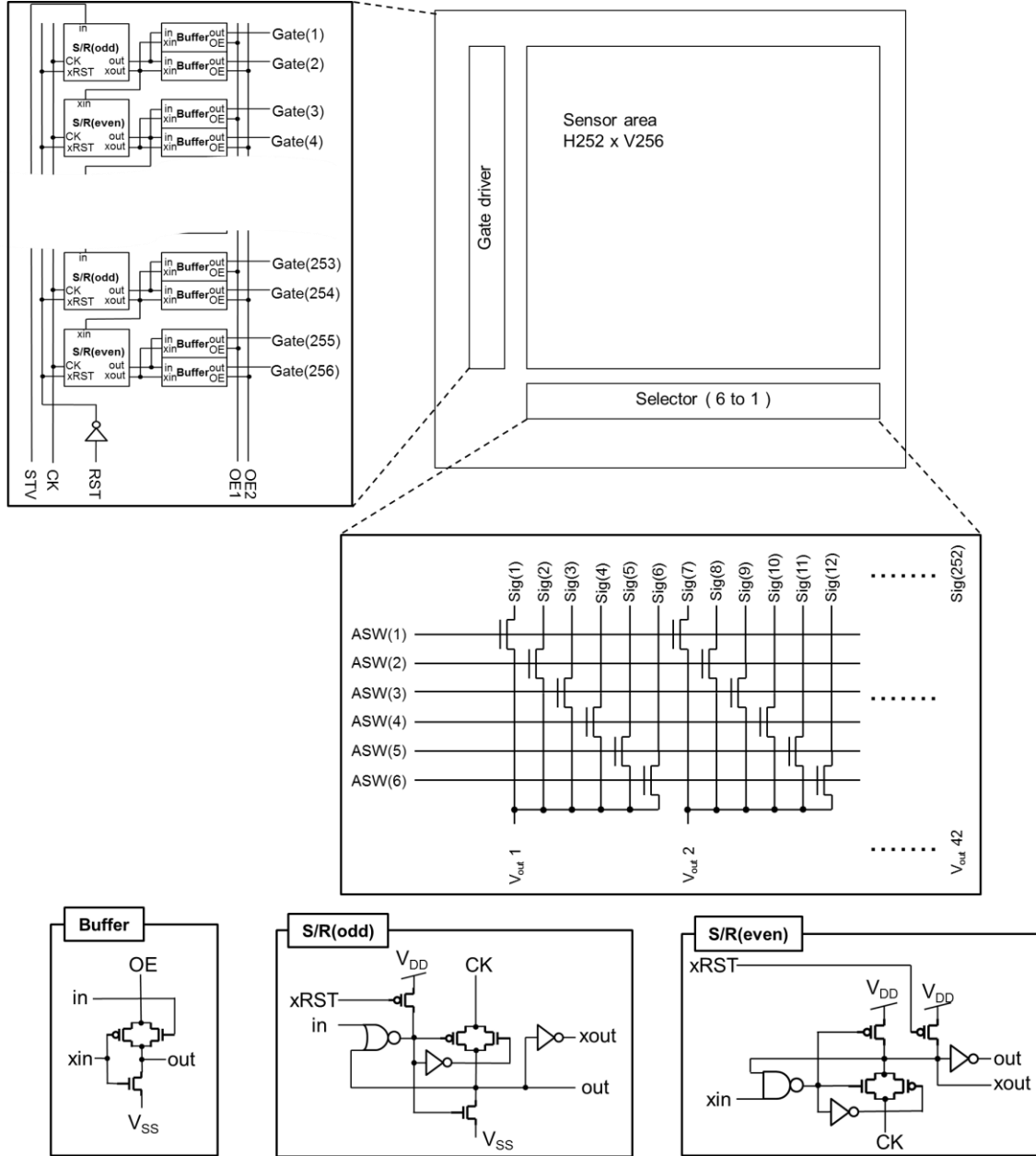
In the format provided by the authors and unedited.

A conformable imager for biometric authentication and vital sign measurement

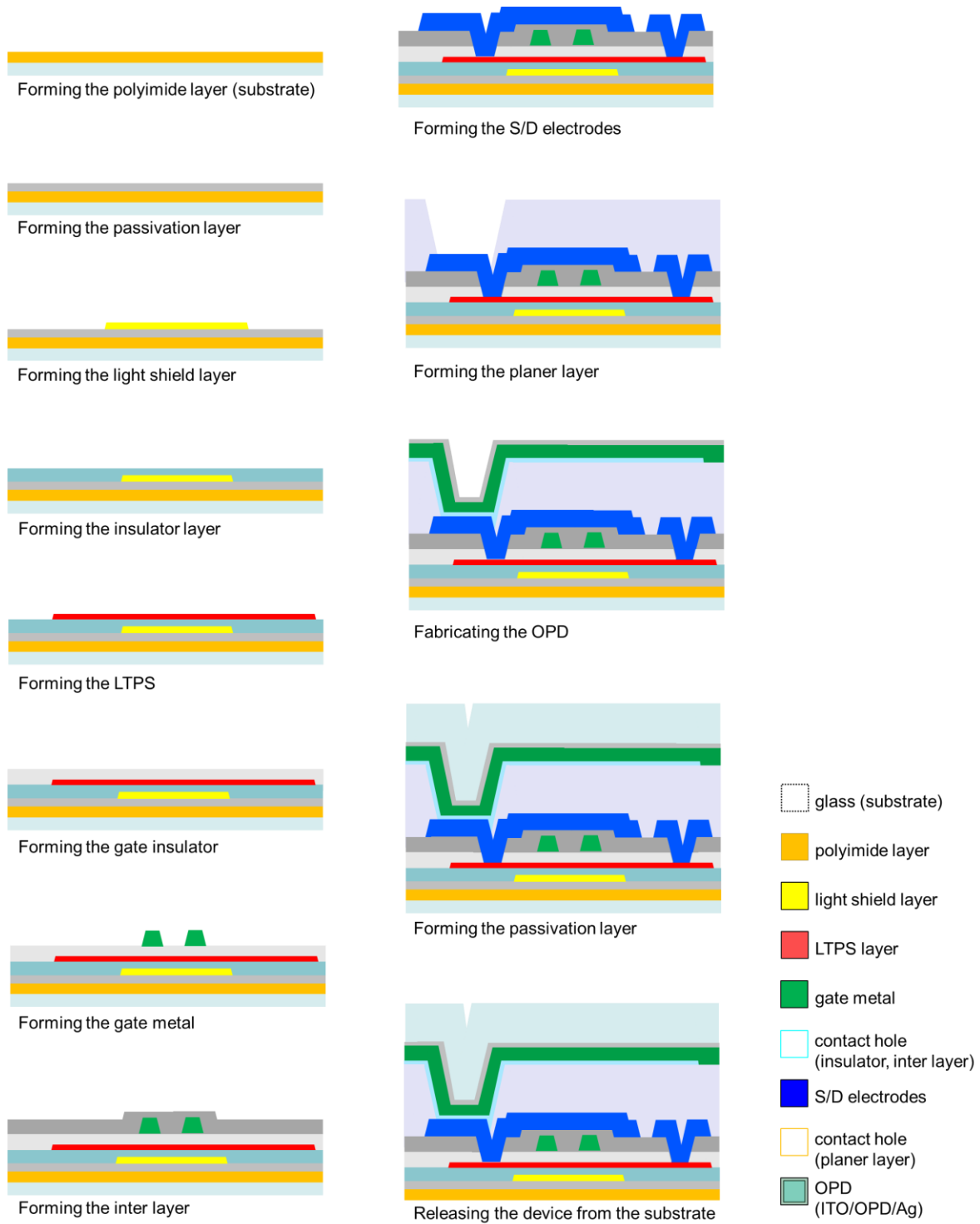
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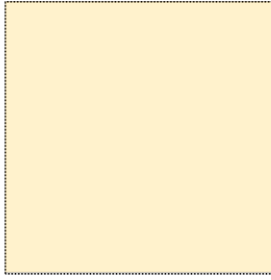
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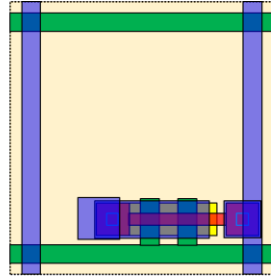
Supplementary Figure 1. Circuit diagram of the conformable imager.



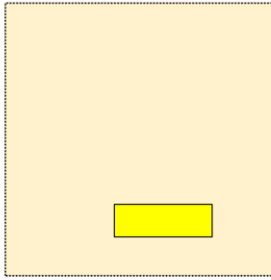
Supplementary Figure 2. Fabrication process of the conformable imager.



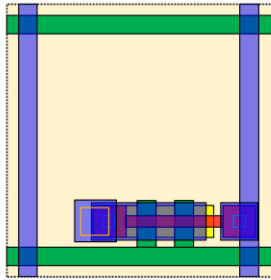
Forming the polyimide layer (substrate)



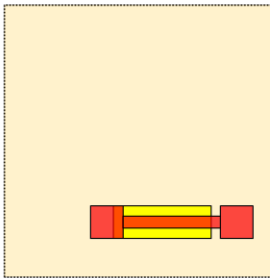
Forming the S/D electrodes



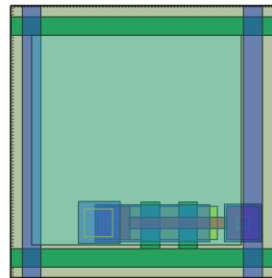
Forming the light shield layer



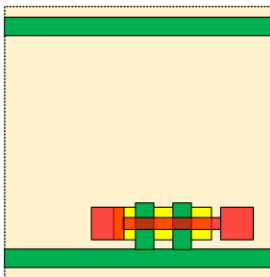
Forming the planer layer



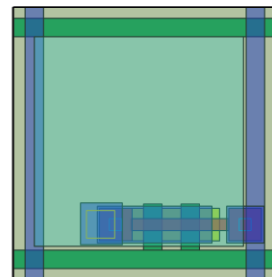
Forming the LTPS



Fabricating the OPD



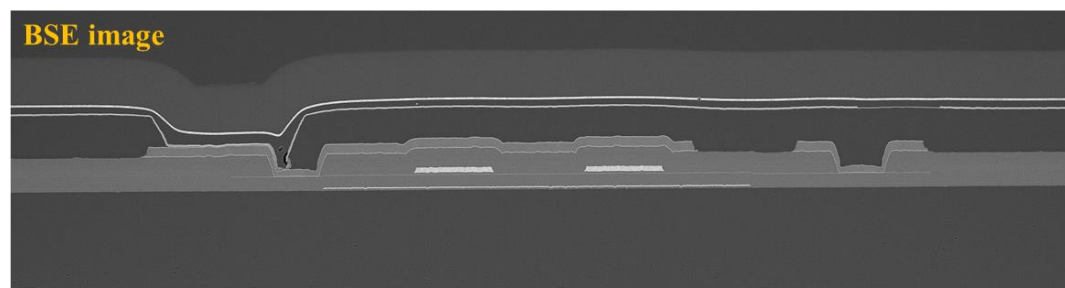
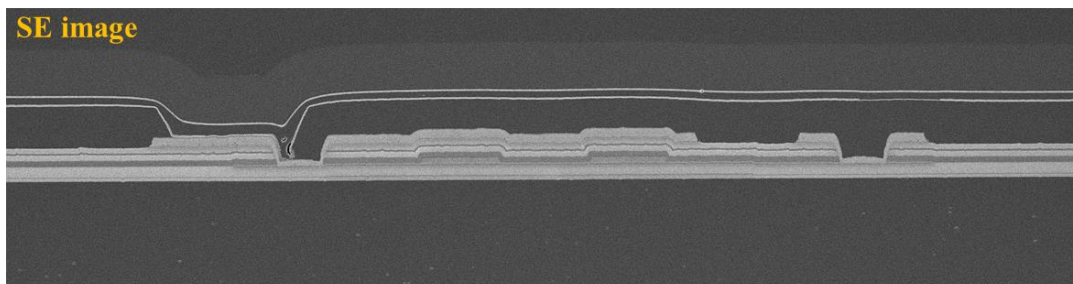
Forming the gate metal



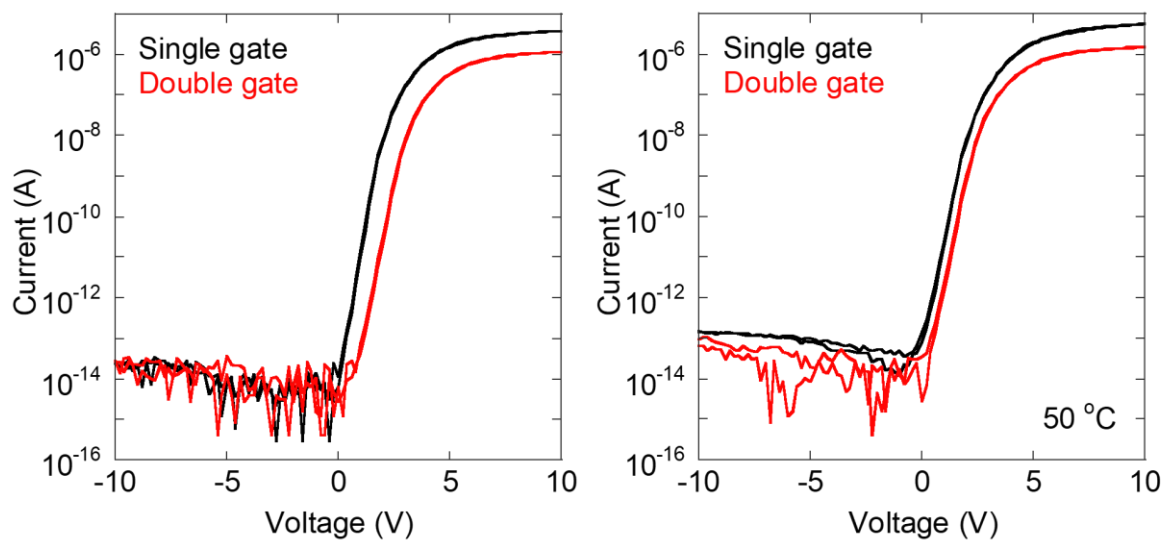
Releasing the device from the substrate

- glass (substrate)
- polyimide layer
- light shield layer
- LTPS layer
- gate metal
- contact hole (insulator, inter layer)
- S/D electrodes
- contact hole (planer layer)
- OPD (ITO/OPD/Ag)

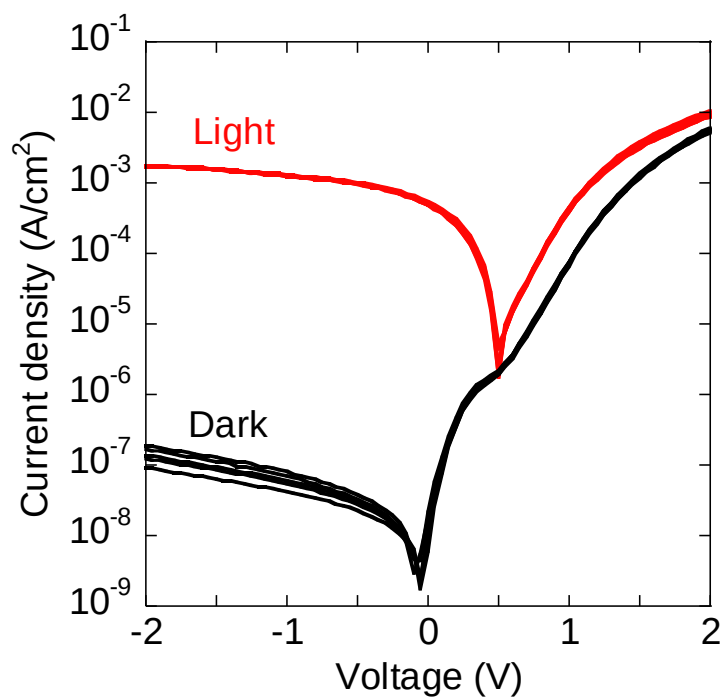
Supplementary Figure 3. Top view of fabrication process of the conformable imager.



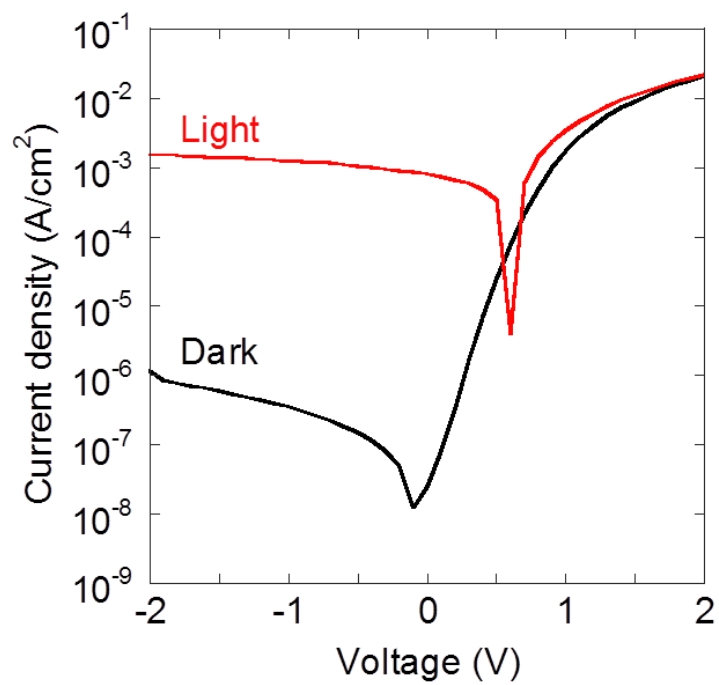
Supplementary Figure 4. Cross sectional image of our conformable imager. Scale bar is 5 μm .



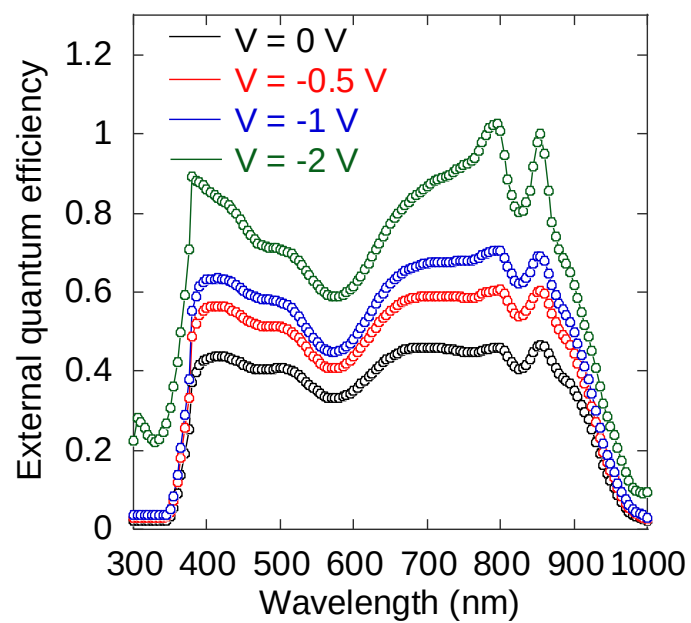
Supplementary Figure 5. I–V characteristics of single- and double-gate transistors: (left) room temperature and (right) 50°C



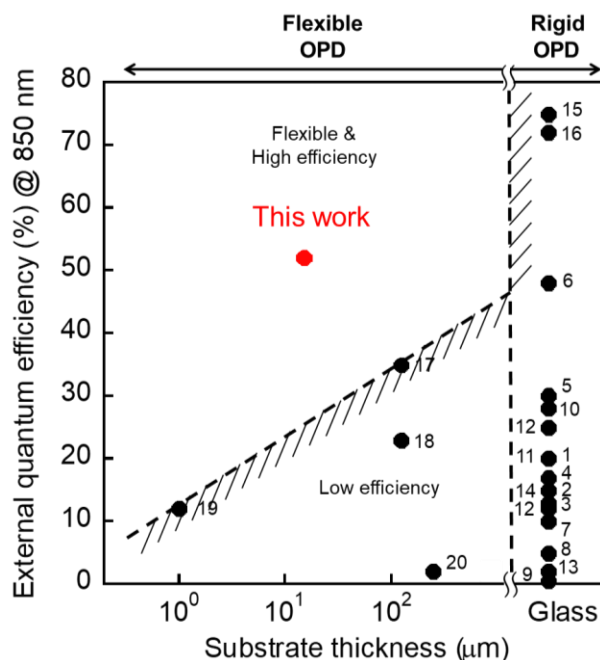
Supplementary Figure 6. Device variations seen among the OPDs (6 samples).



Supplementary Figure 7. J-V characteristics of the organic photodiode with STD-001/PC₆₁BM active layer.



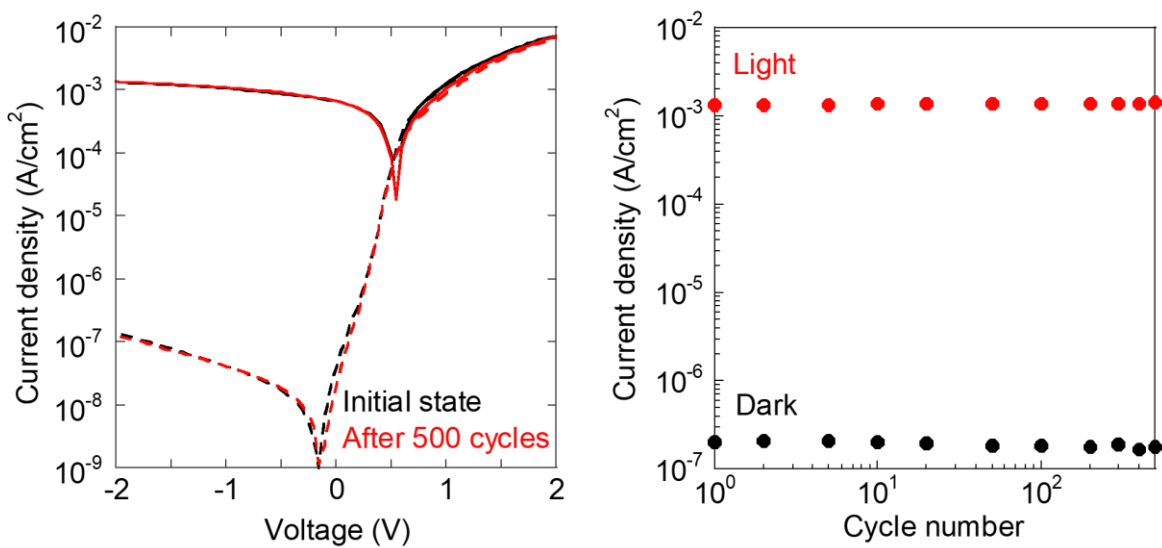
Supplementary Figure 8. External quantum efficiency of the photodiodes at 0 V (black), -0.5 V (red), -1 V (blue), and -2 V (green).



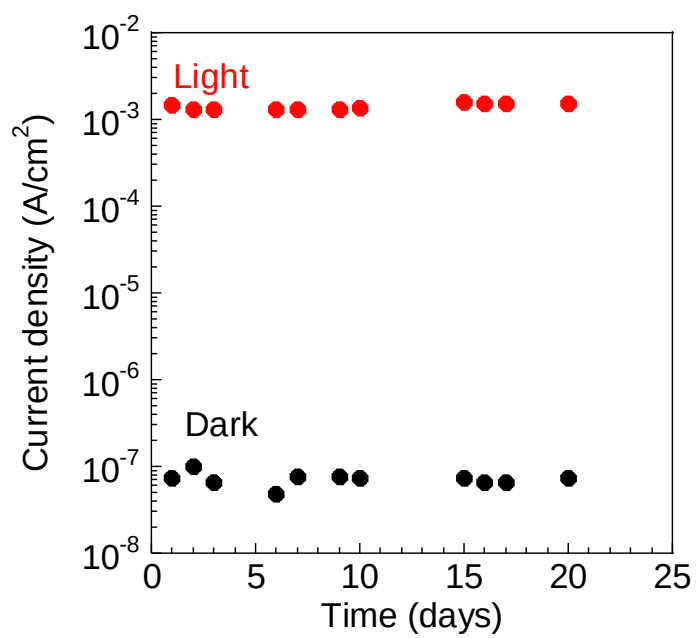
Supplementary Figure 9. Comparison of the external quantum efficiency and substrate thickness between our work/study and recent publications on the NIR OPDs.

- 1 : Y. Yao, et al., *Adv. Mater.*, 2007, 19, 3979–3983.
- 2 : E.-C. Chen, et al., *Synth. Met.*, 2011, 161, 1618–1622.
- 3 : X. Hu, et al., *J. Phys. Chem. C*, 2013, 117, 6537–6543.
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- 5 : T. Yang, et al., *J. Phys. Chem. C*, 2012, 116, 13650–13653.
- 6 : S. Xiong, et al., *J. Mater. Chem. C*, 2016, 4, 1414–1419.
- 7 : L. Zhang, et al., *Adv. Mater.*, 2015, 27, 6496–6503.
- 8 : J. Han, et al., *J. Mater. Chem. C*, 2017, 5, 159–165.
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- 10 : L. Li, et al., *J. Mater. Chem. C*, 2014, 2, 1372–1375.
- 11 : X. Wang, et al., *Org. Electron.*, 2014, 15, 2367–2371.
- 12 : Z. Su, et al., *ACS Appl. Mater. Interfaces*, 2015, 7, 2529–2534.
- 13 : M. Young, et al., *Adv. Opt. Mater.*, 2016, 4, 1028–1033.
- 14 : H. Zhang, et al., *Sci. Rep.*, 2015, 5, 9439.
- 15 : G. Wu, et al., *Small*, 2018, 14, 1802349.
- 16 : J. Lee, et al., *ACS Energy Lett.*, 2019, 4, 1401–1409.
- 17 : Y. Khan, et al., *PNAS*, 2018, 115, E11015–E11024.
- 18 : B. Siegmund, et al., *Nat. Commun.*, 2017, 8, 15421.
- 19 : S. Park., et al., *Adv. Mater.*, 2018, 30, 1802359.

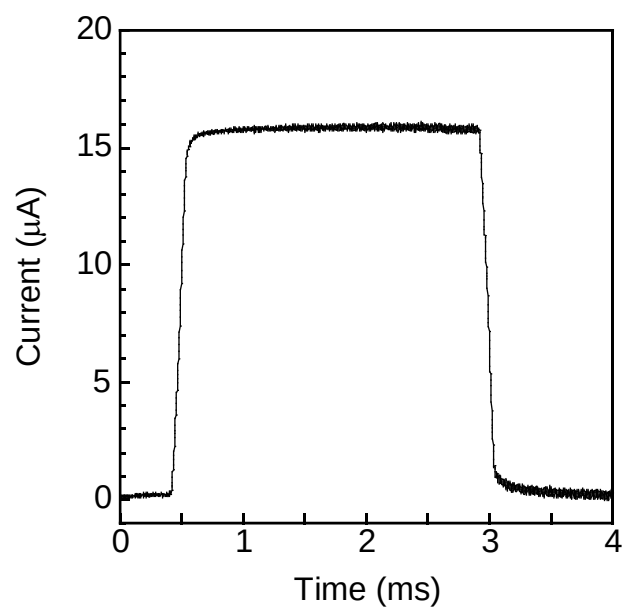
- 20 : X. Xu, et al., *Adv. Funct. Mater.*, 2018, 28, 1805570.
- 21 : L. Dou, et al., *Chem. Rev.* 2015, 115, 12633–12665.
- 22 : X. Liu, et al., *J. Mater. Chem. C*, 2018, 6, 3499–3513.
- 23 : Y. Qin, et al., *SID Sym. Dig. Tech. Papers.*, 2018, 49, 1604–1606.



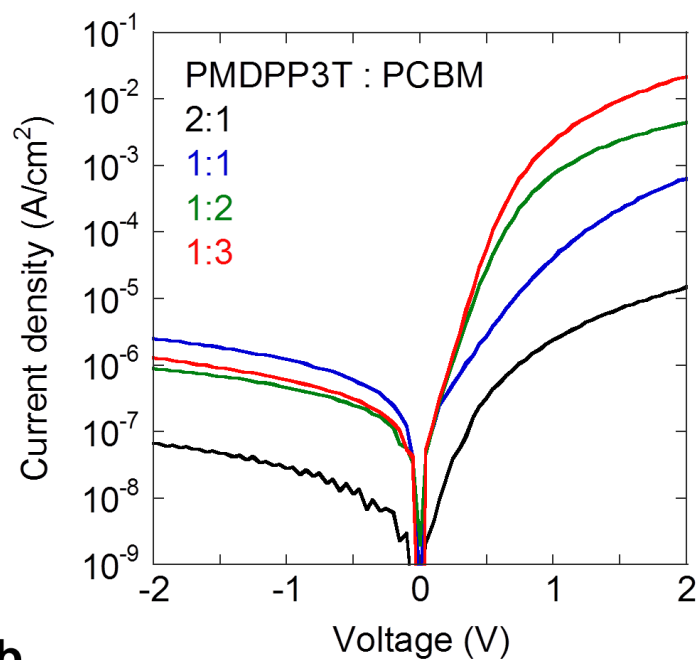
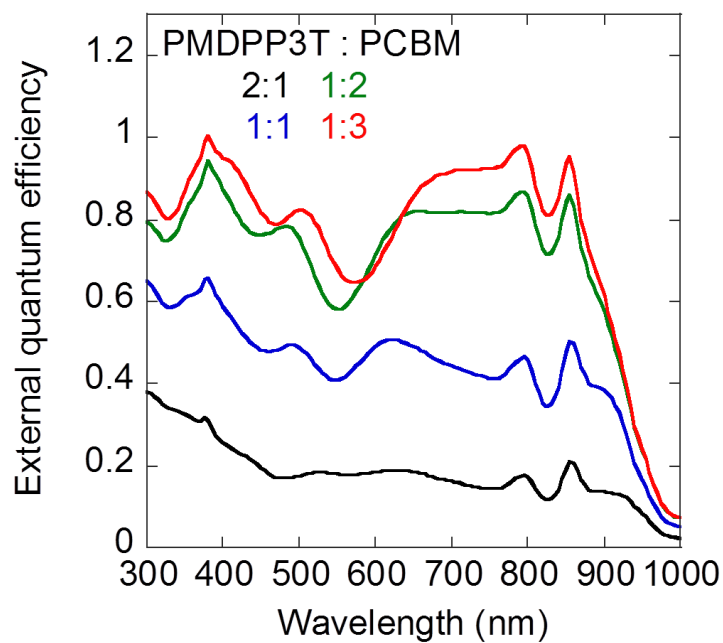
Supplementary Figure 10. The bending test evaluated on our OPD. The OPD was repeatedly bent at a bending radius of 1.6 cm.



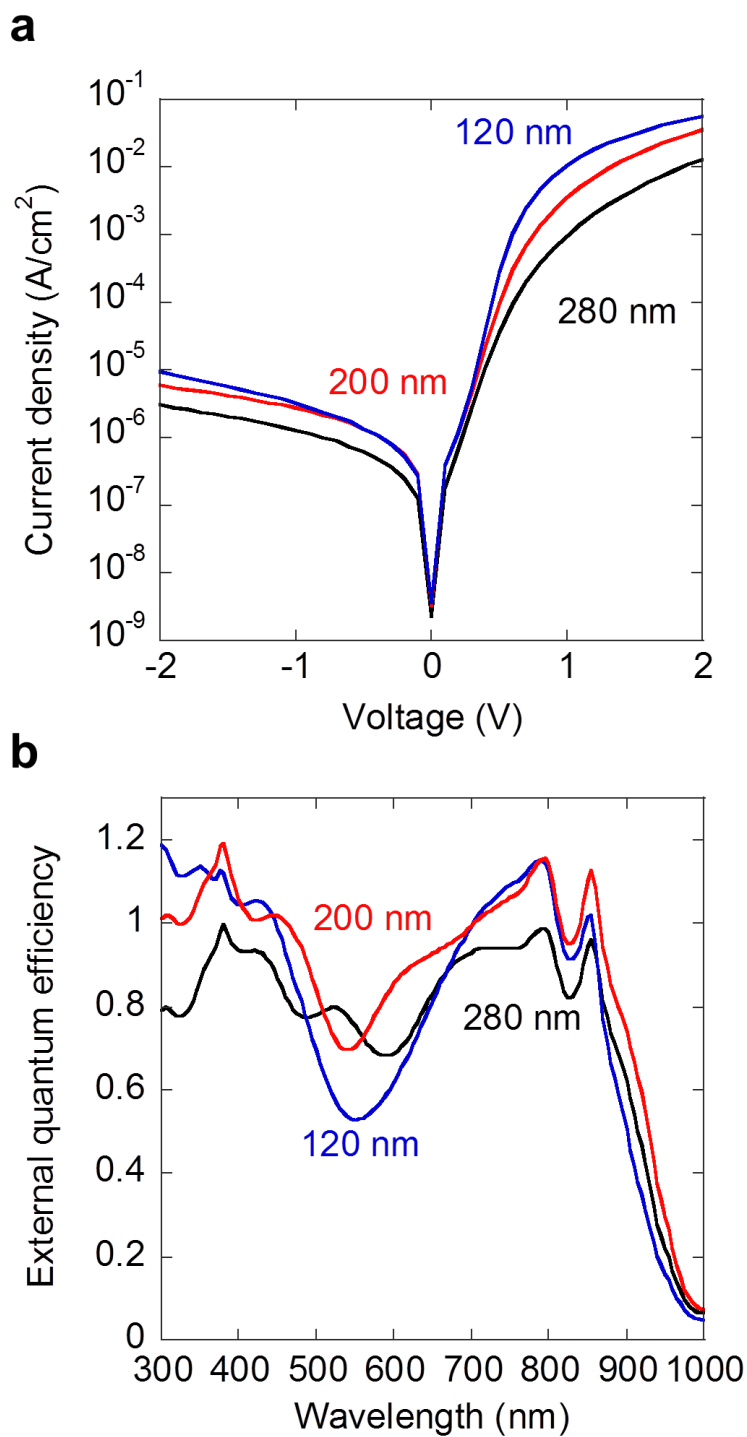
Supplementary Figure 11. Air stability of flexible OPD



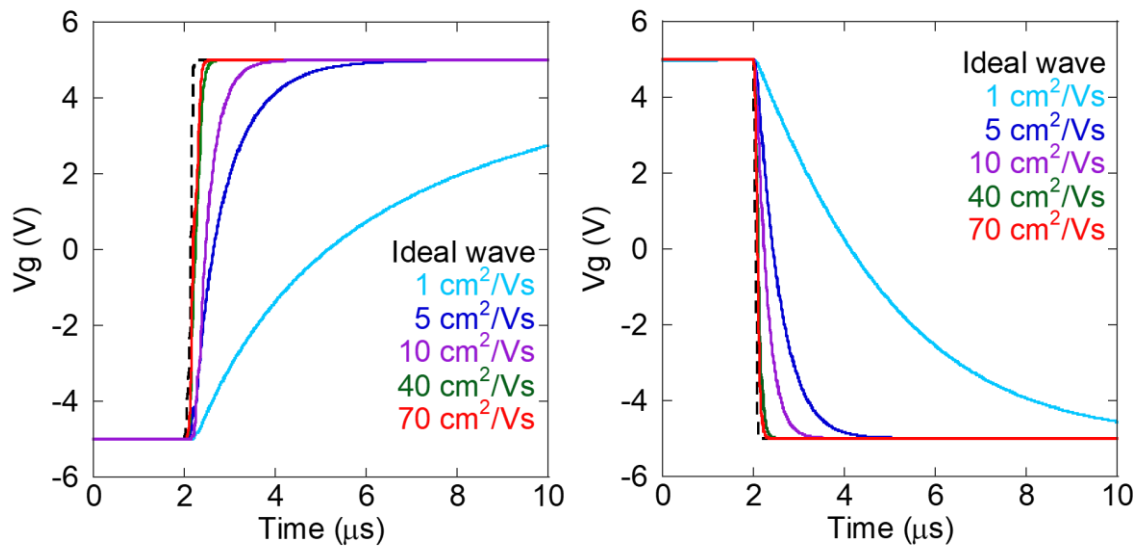
Supplementary Figure 12. Response time of the OPDs

a**b**

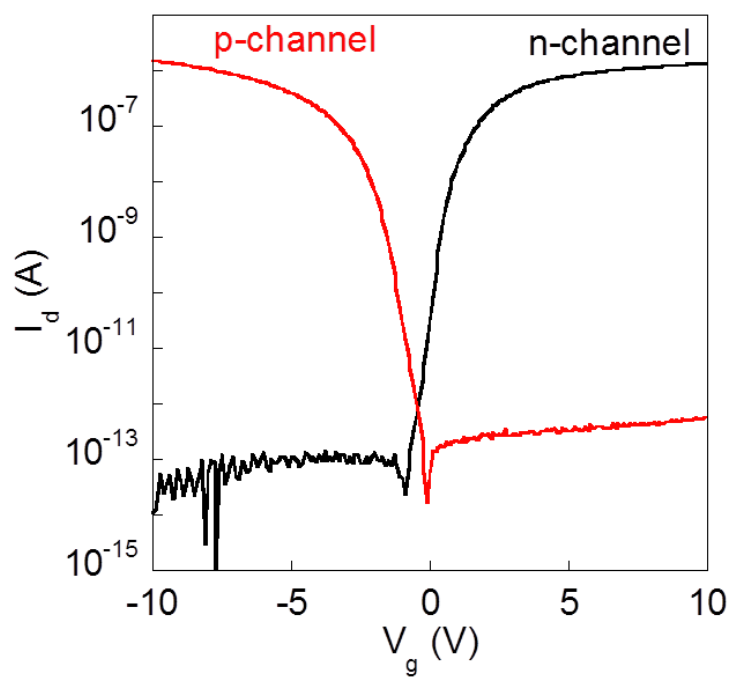
Supplementary Figure 13. Influence of mixing ratio on the characteristics of the organic photodiode. The thickness of active layer is 380 nm (2:1), 310 nm (1:1) 250 nm (1:2) and 280 nm (1:3). **a**, J-V characteristics. **b**, External quantum efficiency of the photodiodes at -2 V.



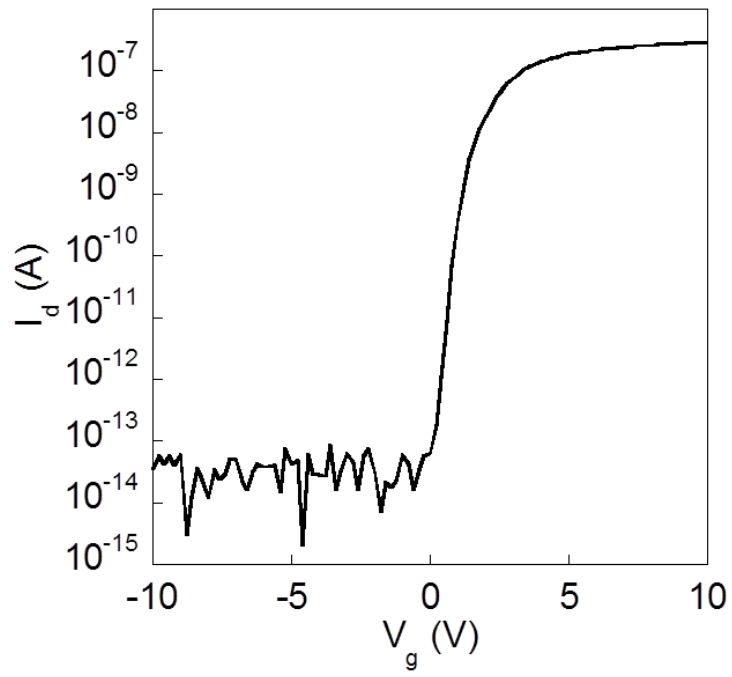
Supplementary Figure 14. Influence of thickness on the characteristics of the organic photodiode. The concentration of ink was 20 gL^{-1} and mixing ratio of PMDPP3T and PC_{61}BM was 1: 3. **a**, J–V characteristics. **b**, External quantum efficiency of the photodiodes at -2 V .



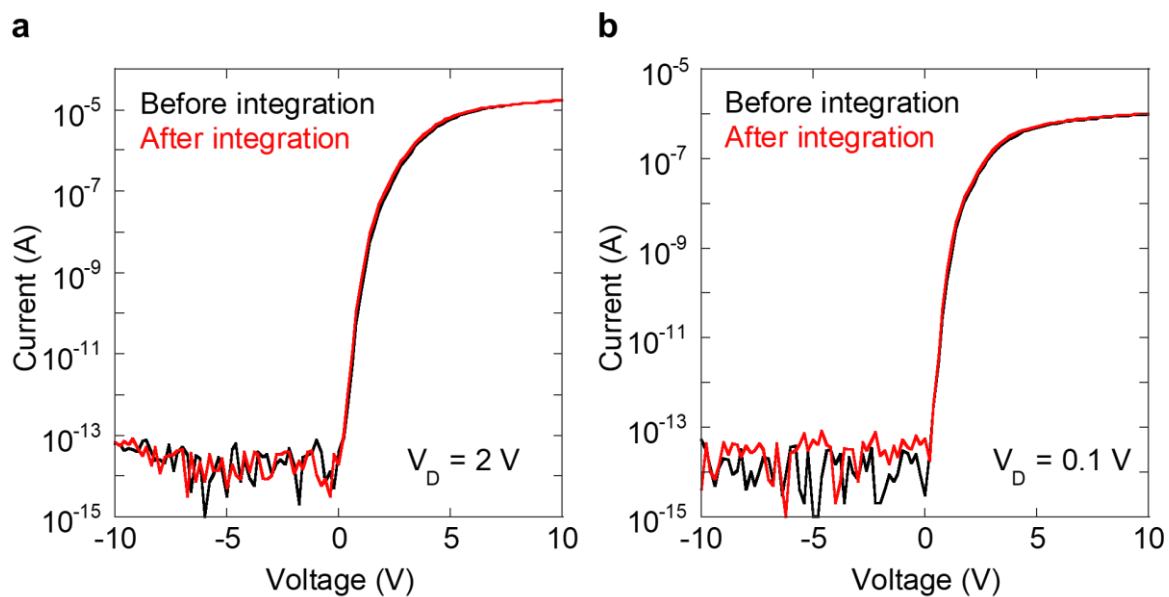
Supplementary Figure 15. The effect of mobility on the shape of the gate waveform is evaluated by the numerical simulation. The response time at mobility of $40 \text{ cm}^2/\text{Vs}$ for LTPS TFTs is as small as $1 \mu\text{s}$. In our readout method, the time-lag from the rising timing in Gate (n) to that in ASW (1) is designed to be $20 \mu\text{s}$. Thus, it is confirmed that the response time of LTPS TFTs ($1 \mu\text{s}$) is much smaller than designed time-lag ($20 \mu\text{s}$). The response time of oxide and amorphous Si TFTs was by 3 times and 70 times larger than that with LTPS TFTs, respectively. Thus, the mobility of organic or amorphous Si TFTs is insufficient to realize a data readout at the frame rate of 41 fps.



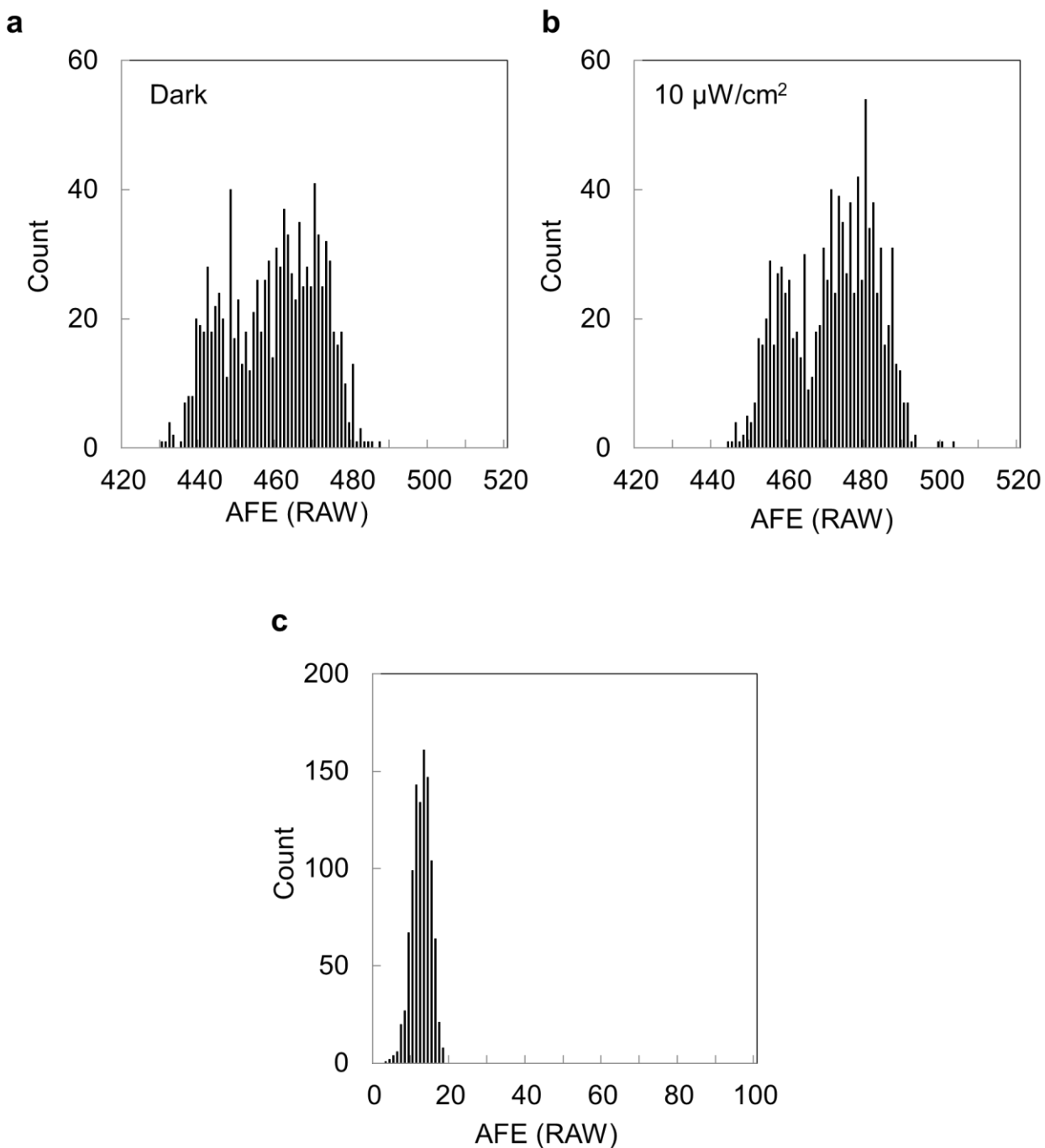
Supplementary Figure 16. Transfer characteristics of the LTPS TFT. The red and black lines represent the p-channel TFT and n-channel TFT characteristics, respectively.



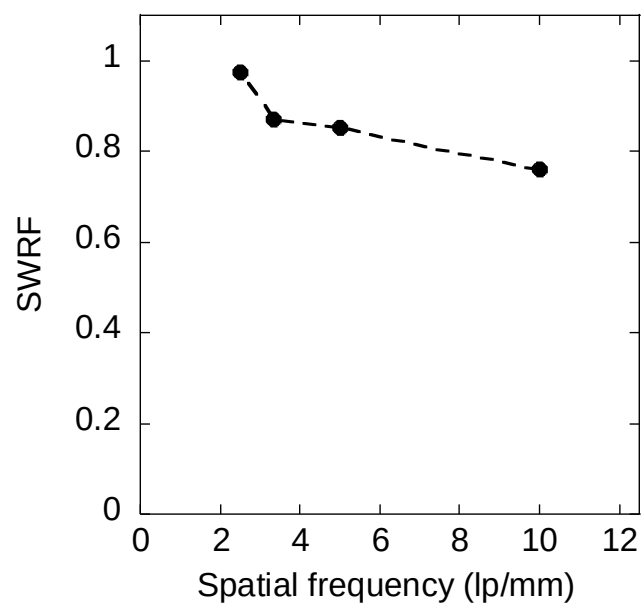
Supplementary Figure 17. Transfer characteristics of the double gate LTPS TFT.



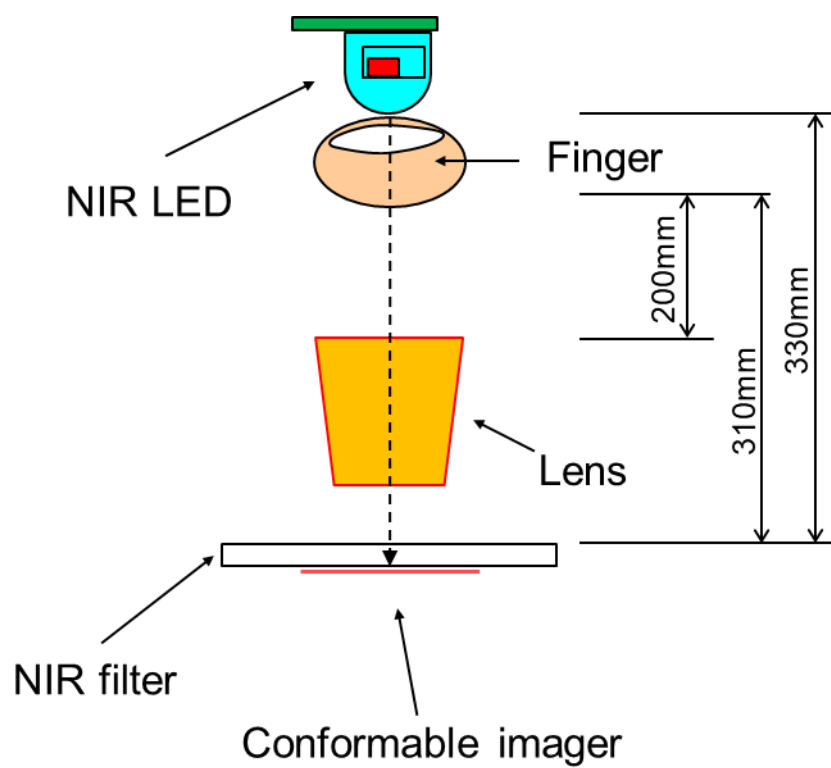
Supplementary Figure 18. I–V characteristics of the LTPS TFT before and after integration. utput characteristics of the double gate LTPS TFT. **a**, $V_D = 2$ V. **b**, $V_D = 0.1$ V



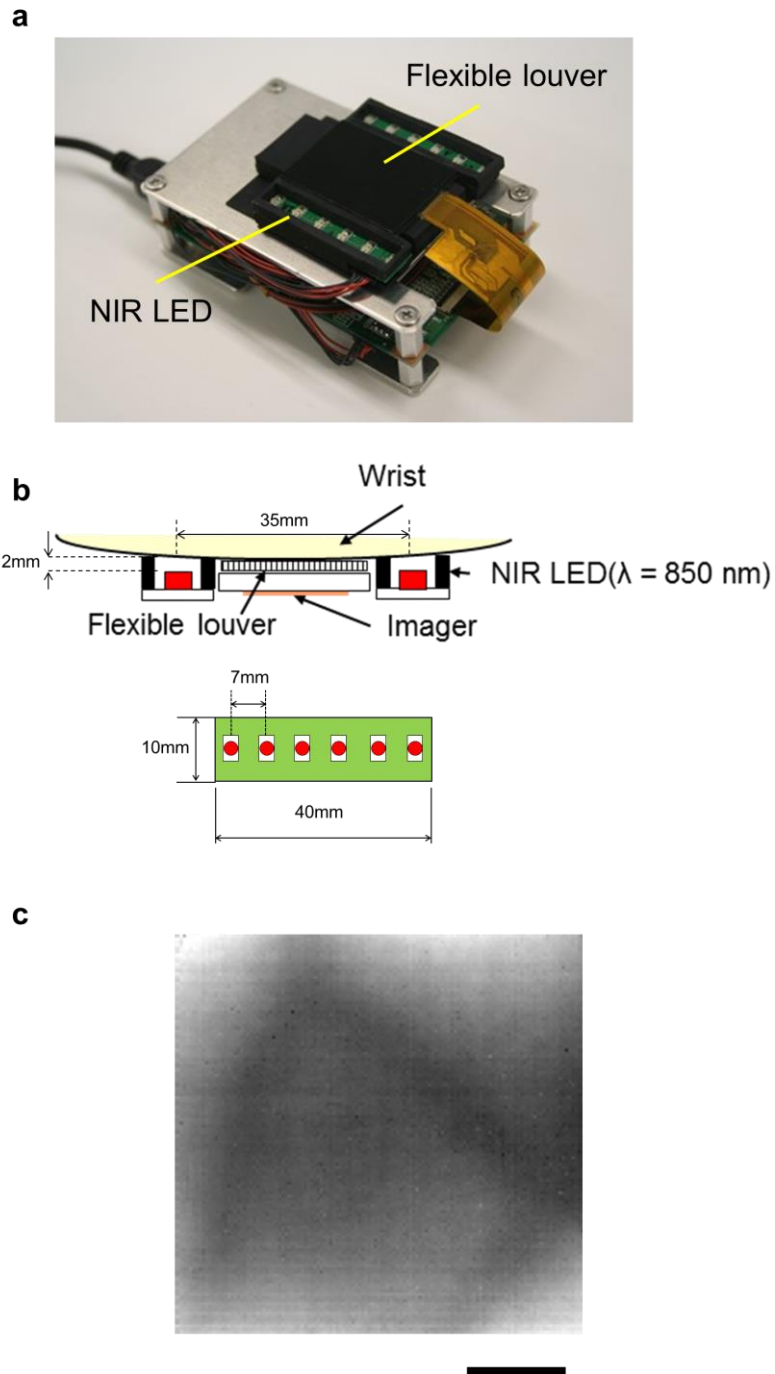
Supplementary Figure 19. Variation of the AFE output signal corresponding to **a**, 0 and **b**, $10 \mu\text{W}/\text{cm}^2$ irradiation. **c**, variation of the AFE output signal using $10 \mu\text{W}/\text{cm}^2$ irradiation following the difference process.



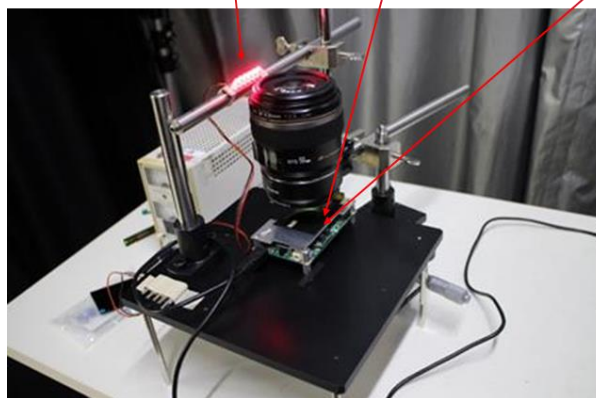
Supplementary Figure 20. SWRF of out imager



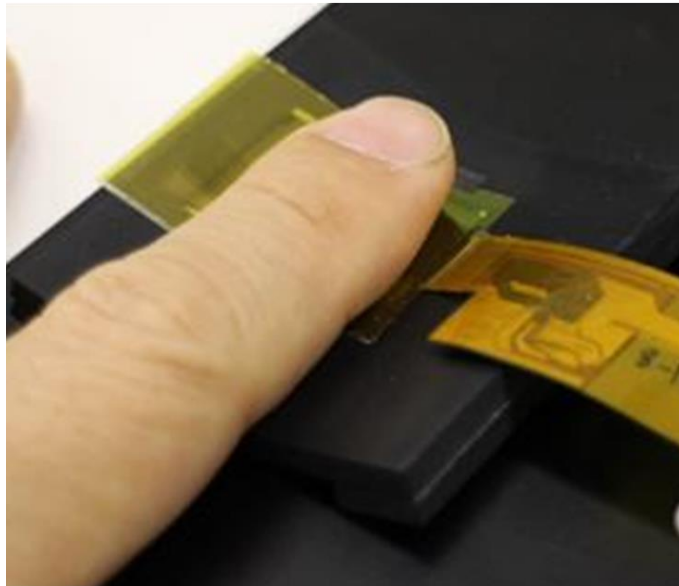
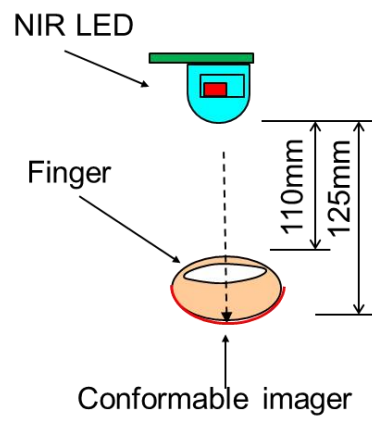
Supplementary Figure 21. Measurement setup of finger vein with optical system



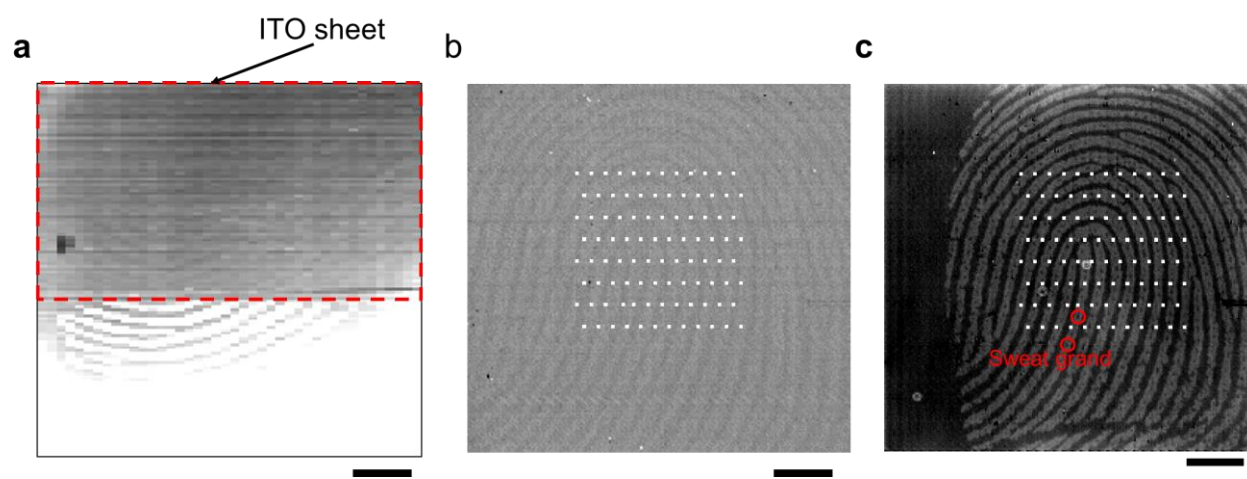
Supplementary Figure 22.: Measurement of wrist vein without optical system. **a**, photograph of the imager system with the flexible optical louver and NIR LED. **b**, schematic of the measurement setup. **c**, wrist vein imaging using the reflection mode. Scale bar is 3 mm.



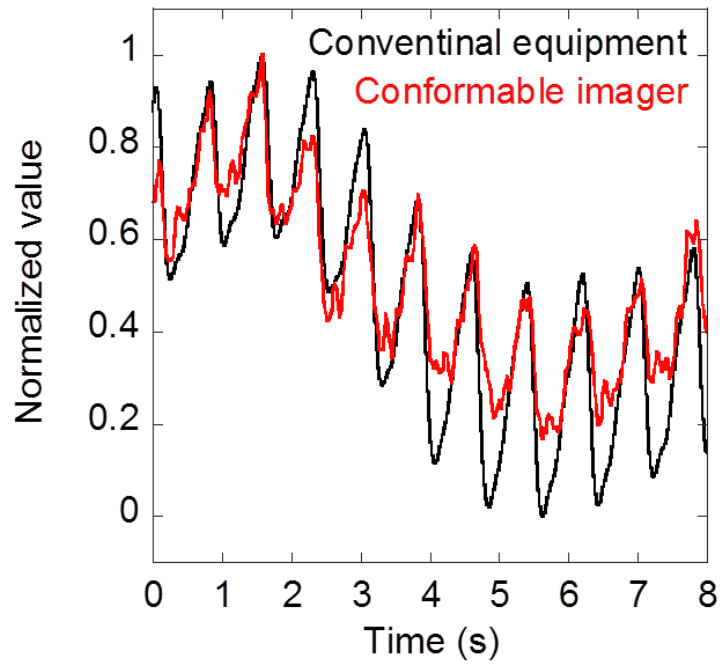
Supplementary Figure 23. Measurement setup of the fingerprint with the optical system.



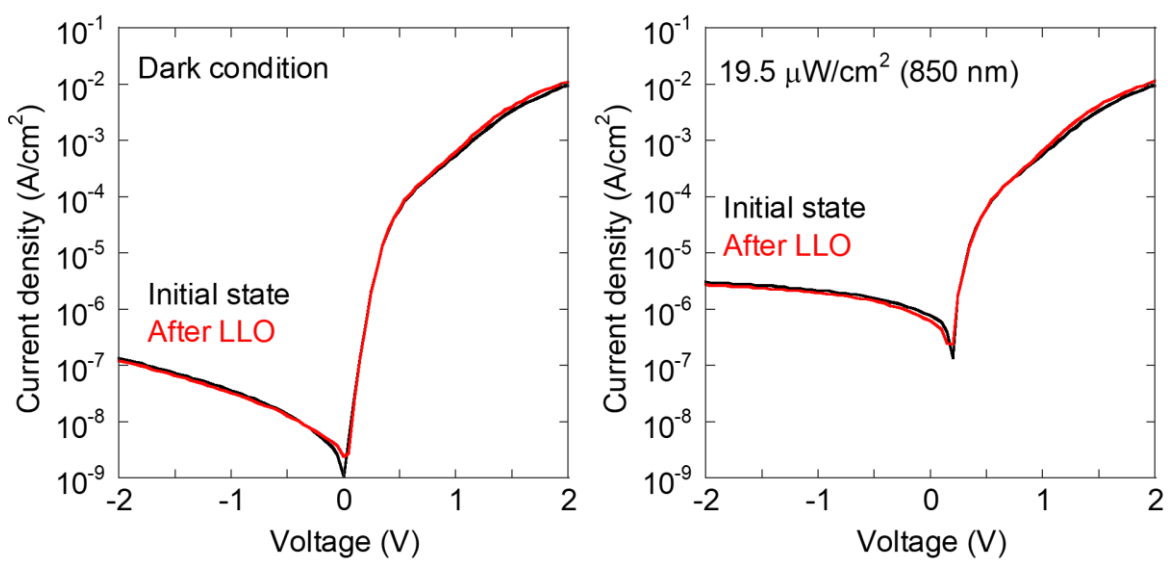
Supplementary Figure 24. Measurement setup of the fingerprint without the optical system. Scale bar is 1 cm.



Supplementary Figure 25. Fingerprint imaging with an ITO sheet. **a**, the ITO sheet was placed on the imager (red dotted line), to take the image of the fingerprint. Scale bar is 2 mm. **b**, Fingerprint imaging in the dark condition. A two-dimensional array of white dots was added intentionally for protecting personal information of biometric identification. The dots are 0.13 mm square and horizontal and vertical pitch is 0.39 and 0.65 mm, respectively. Scale bar is 2 mm. **c**, Imaging of a fingerprint taken by a conformable imager without the optical system. A two-dimensional array of white dots was added intentionally for protecting personal information of biometric identification. The dots are 0.06 mm square and horizontal and vertical pitch is 0.18 and 0.3 mm, respectively. Scale bar is 2 mm. Scale bar is 1 mm.

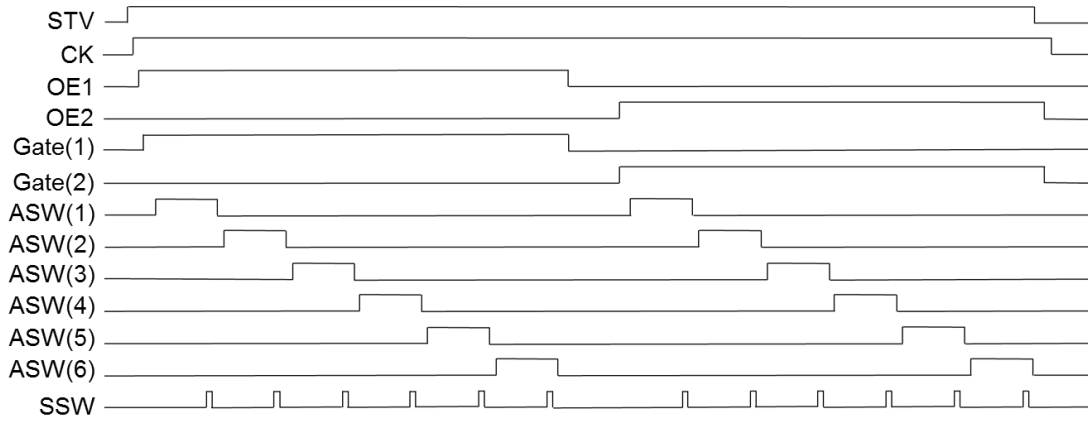


Supplementary Figure 26. Comparison of the PPG signal taken by a conventional pulse monitor system (black) with the PPG signal taken by our conformable imager (red).

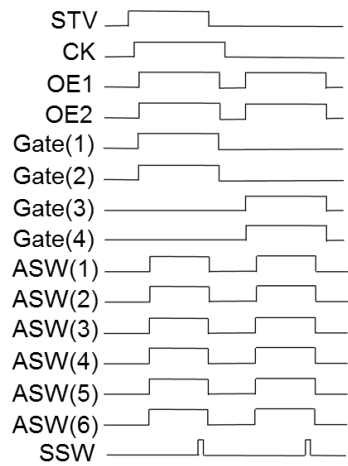


Supplementary Figure 27. Effect of the laser lift-off process

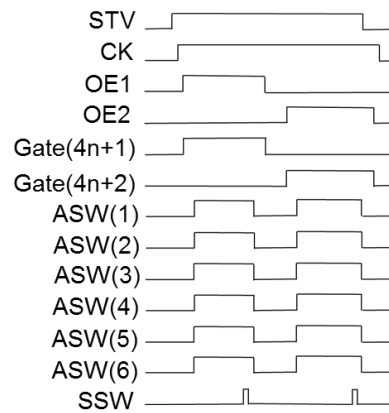
Case A: 252 × 256 mode



Case B: 42 × 128 mode



Case C: 42 × 4 mode



Supplementary Figure 28. Timing chart of the control signals in case of 252 × 256 mode (Case A), 42 × 128 mode (Case B), and 42 × 4 mode (Case C).