Design Consideration of Front Deep Trench Isolation (FDTI) in Small-pitch, Dual-Photodiode Pixels

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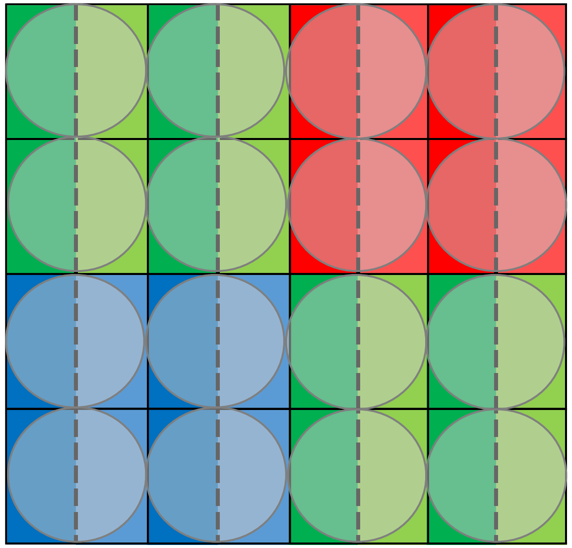
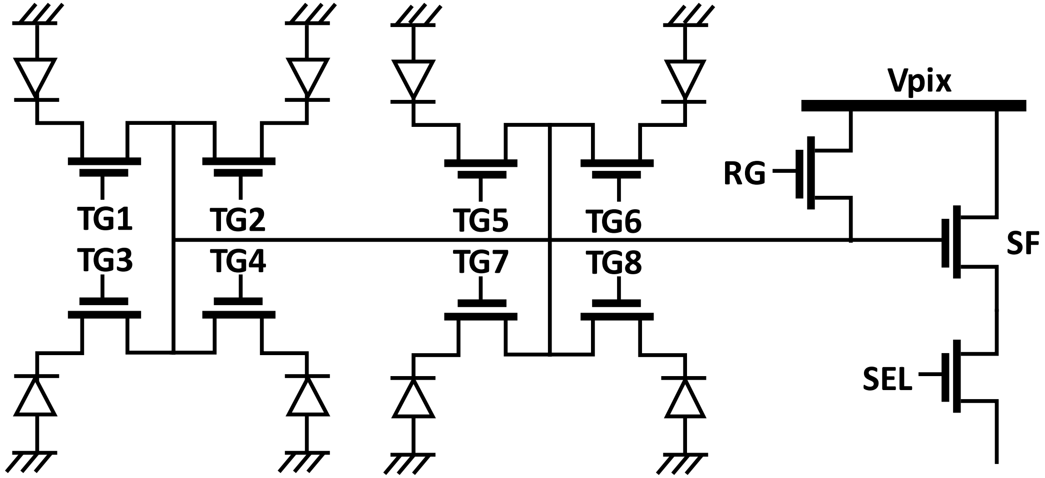
Outline

- Introduction
- Device Structure
- Advantages of novel structure
- Summary

Motivation

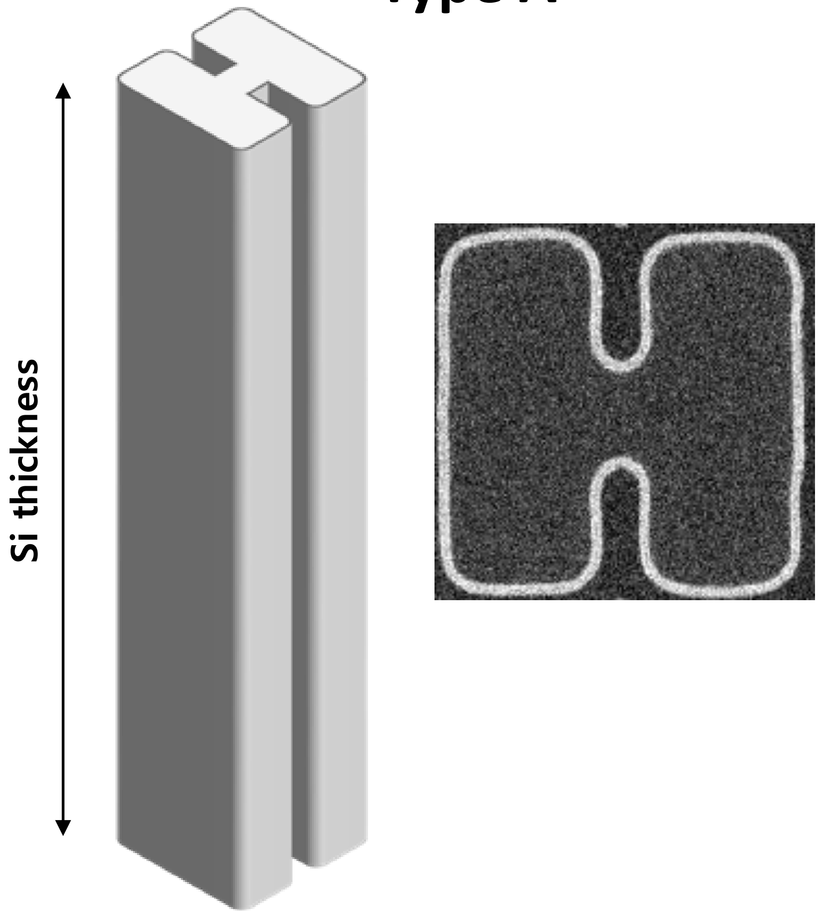
For *FDTI-based* dual photodiode pixels, what is its optimal structure to make pixels smaller?



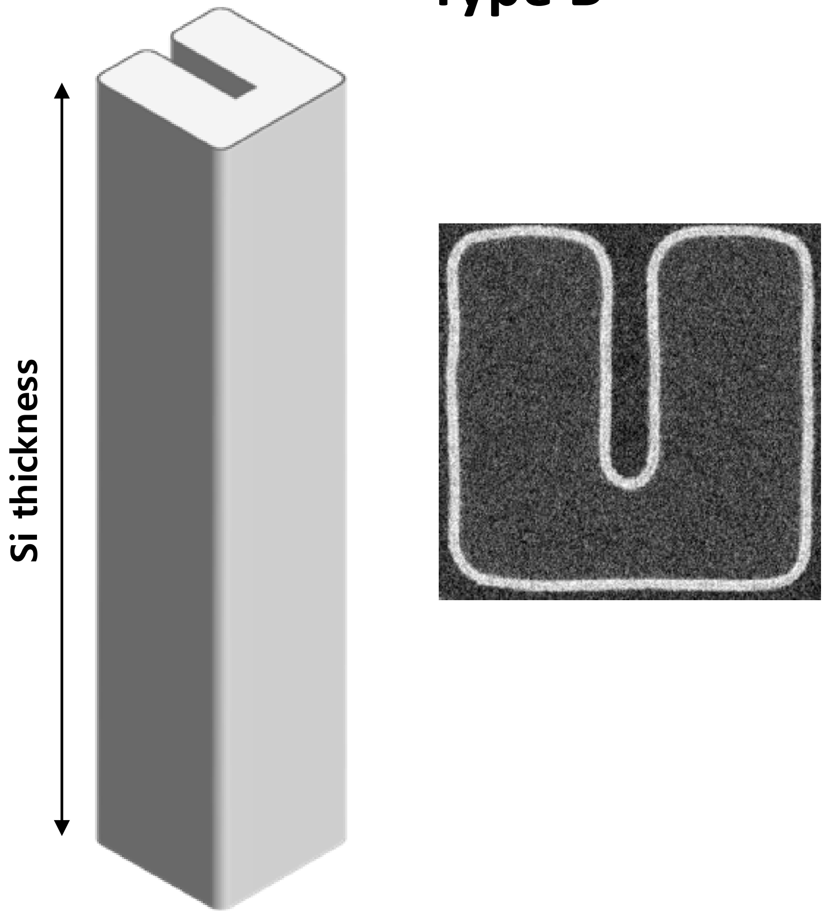


Deep Trench Isolation for Dual-Photodiode Pixels

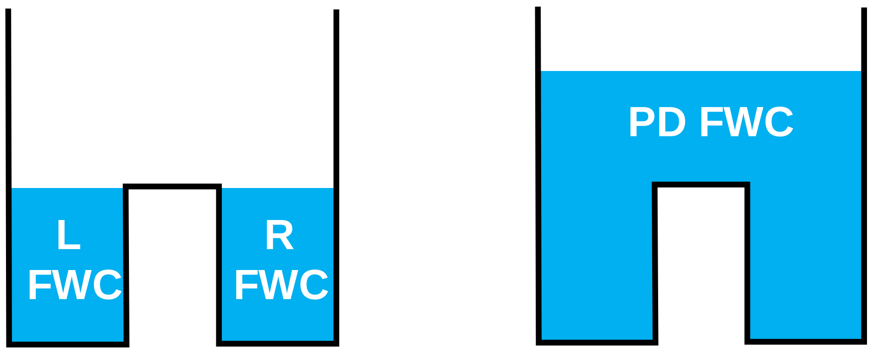
Type A



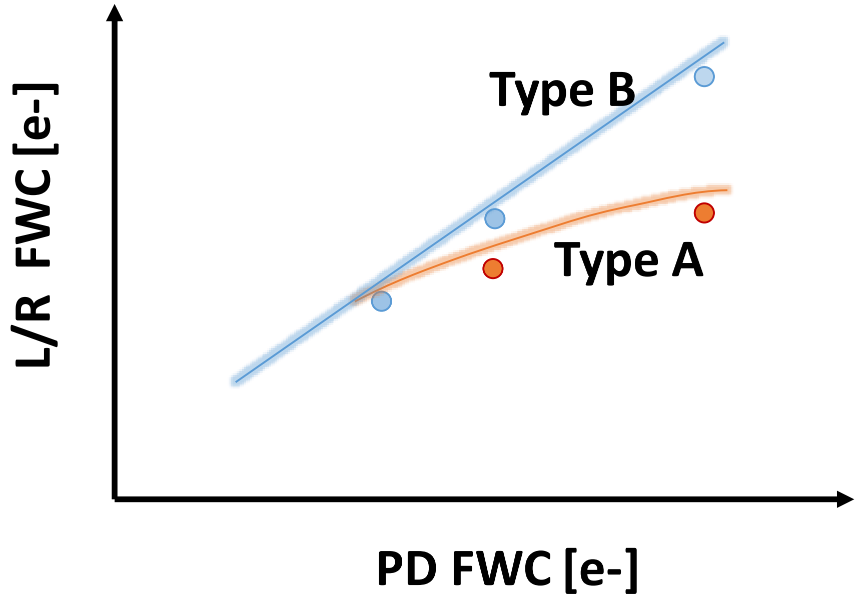
Type B



Dual-Photodiode Pixels



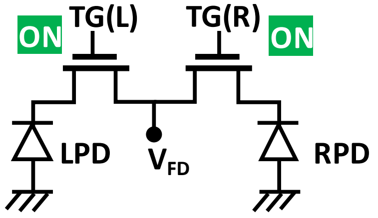
FWC = Full Well Capacity [e-]



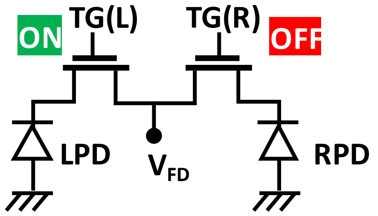
Measurement of Potential Barrier in Dual Photodiode

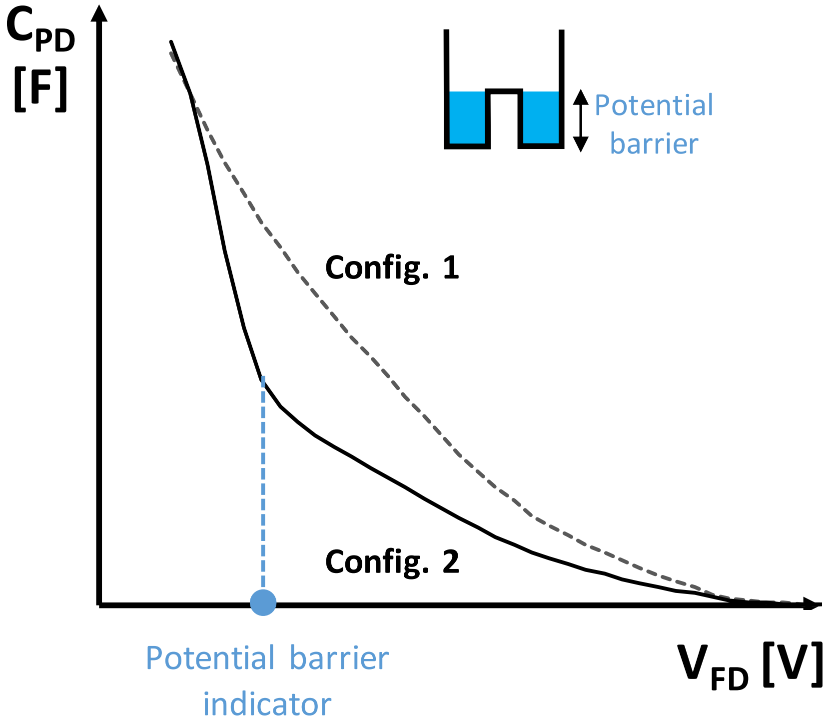
TEG measurement

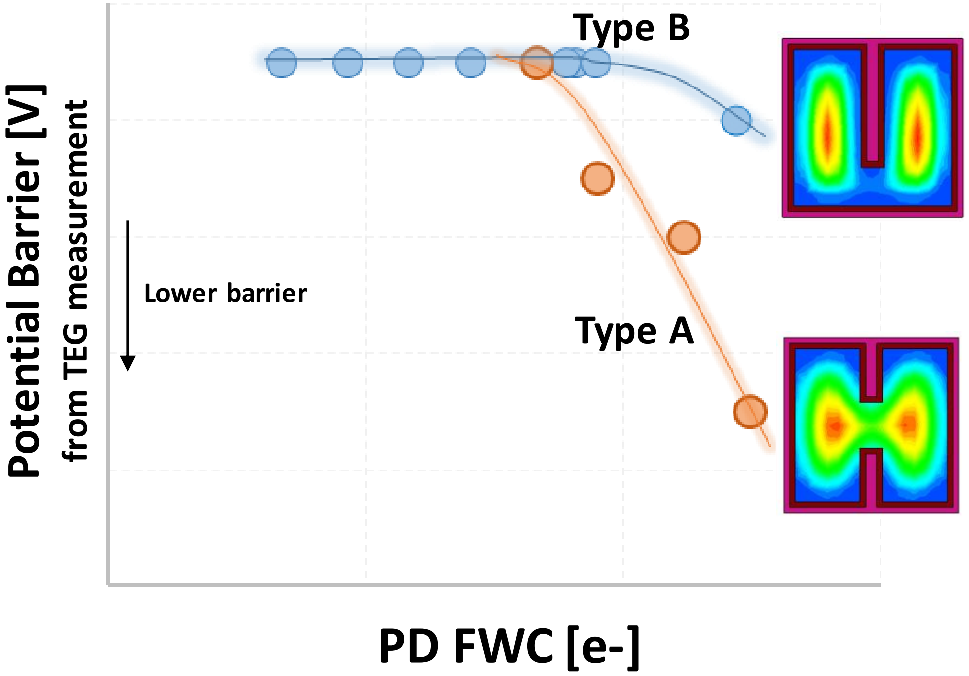
Config. 1:



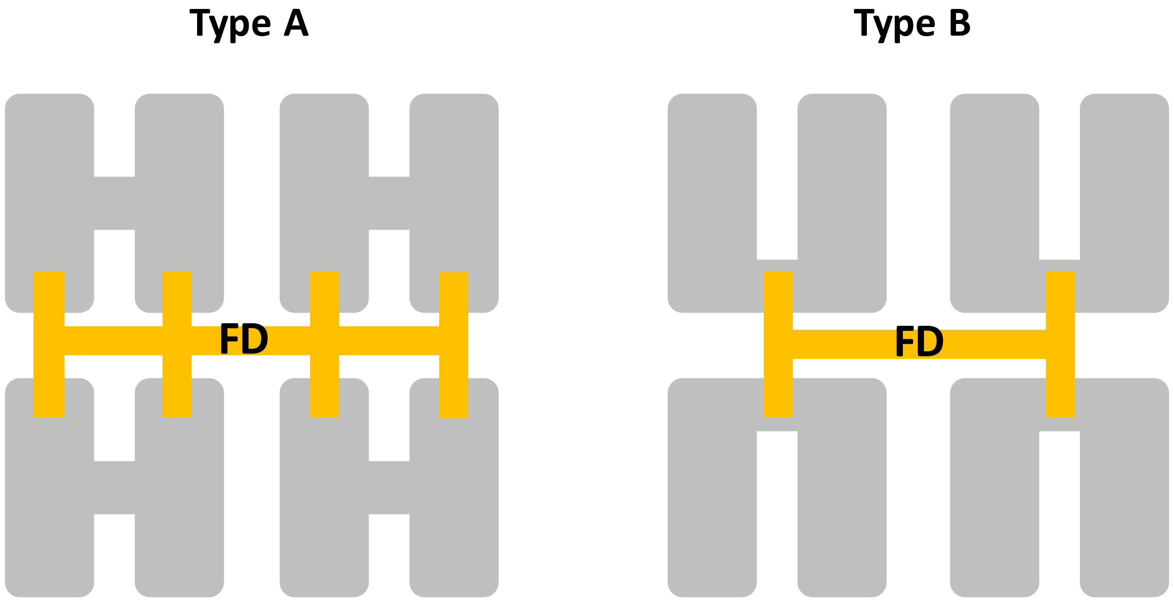
Config. 2:

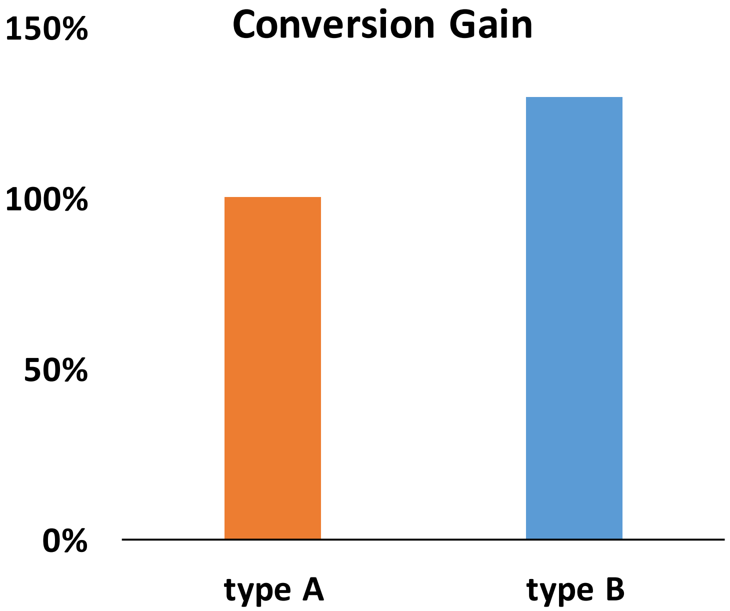






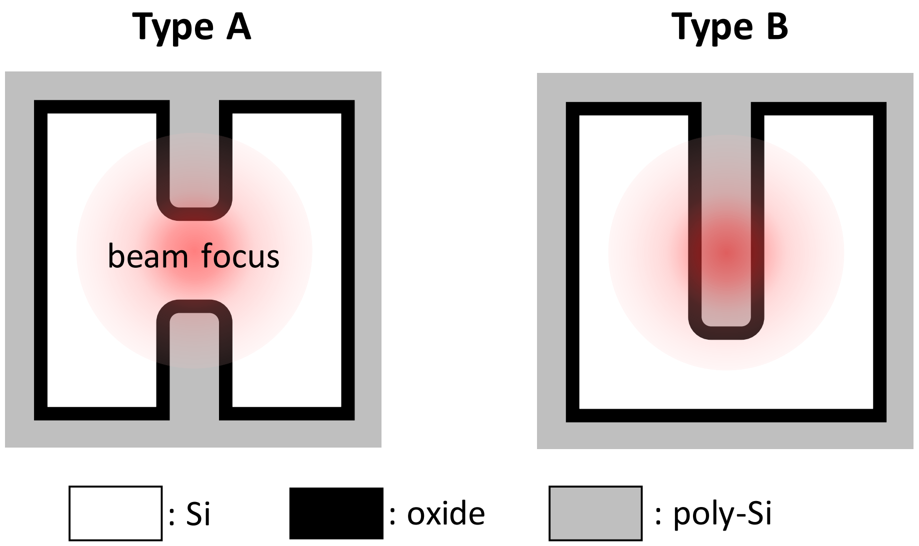
Conversion gain: layout dependence

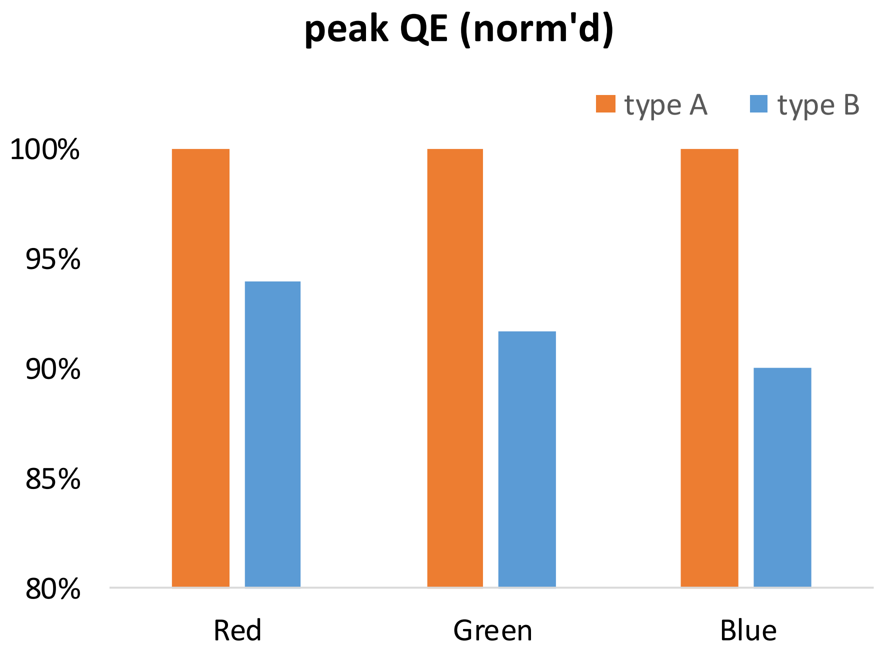




Additionally, In terms of *GIDL* in TG, type B also has a larger margin!

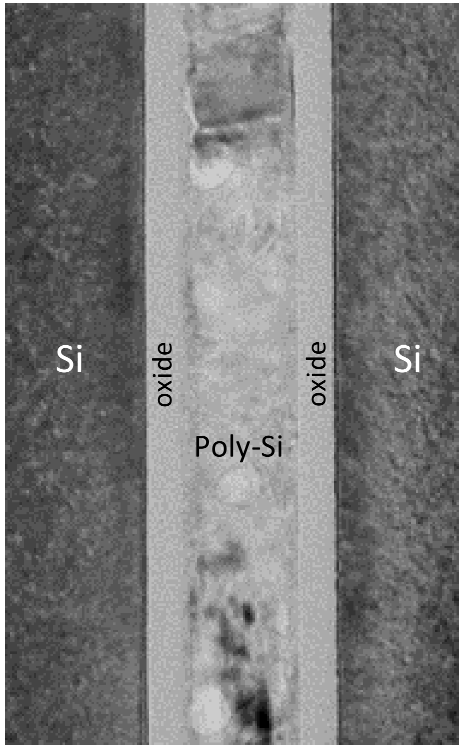
Quantum Efficiency: layout and process dependence



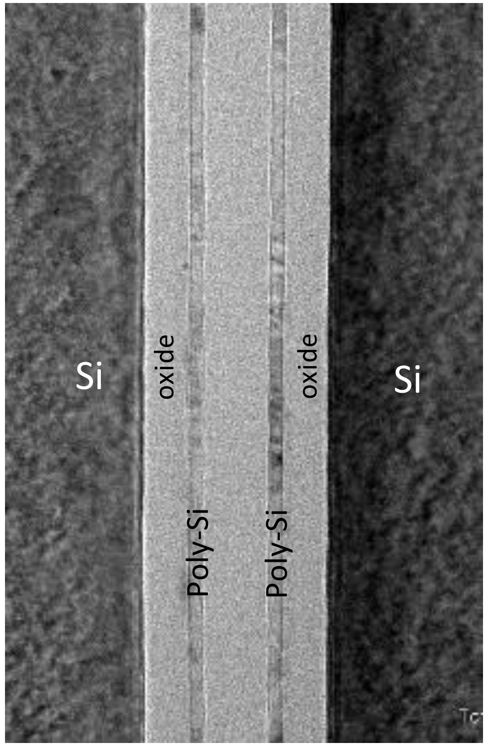


Quantum Efficiency: impact of DTI structure

Conventional DTI

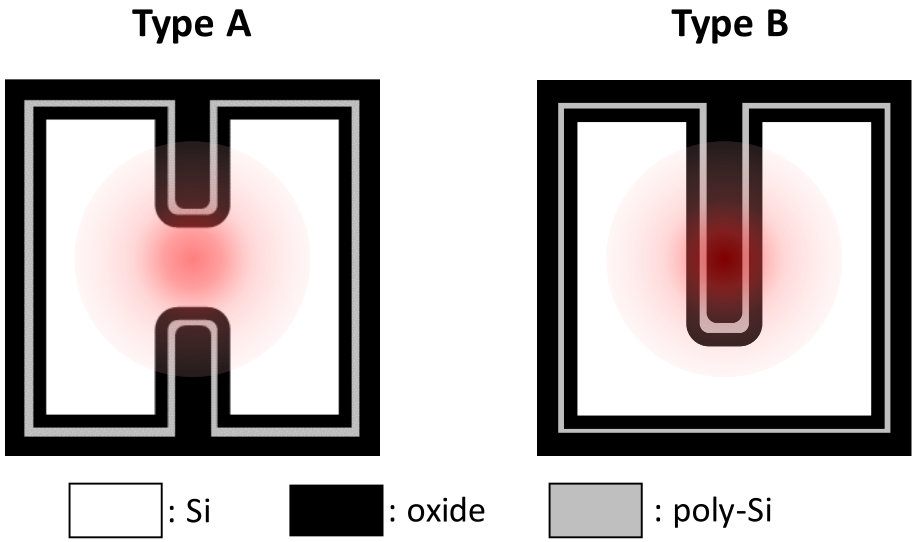


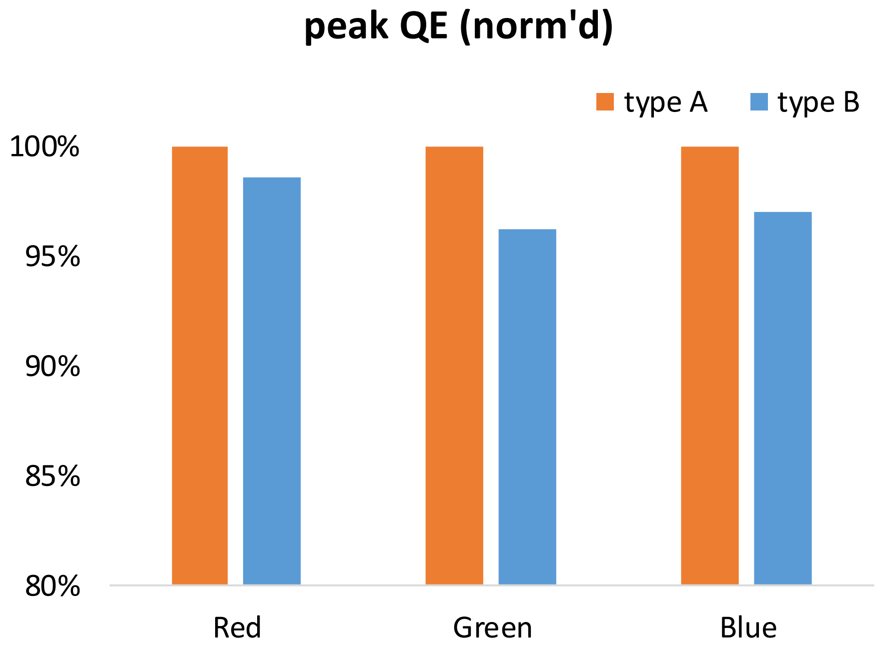
DTI with thinner poly-Si layer [1]



[1] D. Kim et. al., "A 1/1.56-inch 50Mpixel CMOS Image Sensor with 0.5µm pitch Quad Photodiode Separated by Front Deep Trench Isolation", *ISSCC* 2024.

Quantum Efficiency: layout and process dependence





Scattering of photon due to the oxide in pixel's center area might be also taken care of.

Conclusion

■ **Comparison of two distinct DTI structure for small-pitch dual PD pixels.**

- Type B shows superior performance in terms of electrical metric

  : inter-PD potential barrier, conversion gain, GIDL, etc.

- Type A achieves higher Q.E. based on DTI filled with polysilicon

  : The Q.E. gap can be minimized by DTI with thinner polysilicon layer.