2026.7 | Literature Reading:

OPDs and SWIR Photodetectors

2026-07-10 – 2026-08-02

1: Learning

- **Literature study:**

For the first time, I systematically read three review papers covering the working principles and performance metrics of OPD, the mechanisms of dark-current generation and suppression, and the material systems, device architectures, and applications of SWIR photodetectors.

- **Model reproduction and visualization:**

I used Python to reproduce dark-current models and plots, investigating how barrier height, energetic disorder, carrier mobility, active-layer thickness, and reverse bias affect dark current. I also drew device energy-level diagrams to understand the functions of different charge-transport and blocking layers.

2: Highlights

- I completed my first systematic reading of academic papers and began developing a structured approach to literature reading, gradually shifting from textbook-based learning toward research-question-oriented study.
- I gained an understanding of the complete photoconversion process in OPDs, from light absorption, exciton generation and diffusion, and the formation and dissociation of CT states to charge-carrier transport and collection. I also learned the relationships among major performance metrics such as EQE, responsivity, and dark current.
- I recognized that dark current in OPDs is affected by multiple factors, including carrier injection from electrodes, thermally generated carriers, energetic disorder, trap states, interfacial defects, pinholes, moisture, and oxygen. I also conducted a preliminary comparison of SWIR photodetectors based on III–V semiconductors, metal chalcogenides, low-dimensional materials, and organic semiconductors, gaining an understanding of the trade-offs among sensitivity, response speed, cost, room-temperature operation, and device integrability.

3: Insights & Takeaways

- Organic SWIR photodetectors offer potential advantages such as low cost, solution processability, mechanical flexibility, and spectral tunability. However, their narrower bandgaps can also increase thermally generated carriers, dark current, and noise. A central challenge is therefore to extend the spectral response while maintaining high detectivity.
- The three review papers helped me establish an overall knowledge framework for OPDs and SWIR photodetectors. The next stage should move

beyond broad review reading by selecting a specific research question, studying recent original research papers, and attempting quantitative analysis.

4: Challenges & Open Questions

- I still find it difficult to quickly determine which topics require in-depth study, particularly the fabrication processes of inorganic photodetectors and plasmonic structures involving electromagnetics.
- I still need to identify a suitable and well-defined topic for my first research project.

5: Following Plan

- Focus on a specific subtopic within organic SWIR photodetectors, begin reading recent original research papers, and organize their material systems, device architectures, performance metrics, and main limitations.
- Continue reproducing key models and experimental results while strengthening my knowledge of semiconductor device physics, noise analysis, and basic fabrication and characterization methods, gradually turning my understanding of the literature into researchable questions.