'PHOTOMALUS': Designing a device for semiconductor photosensitivity

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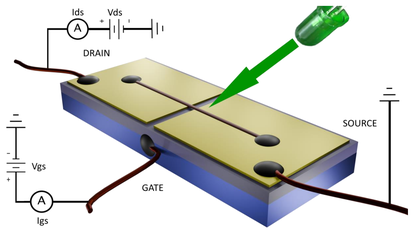
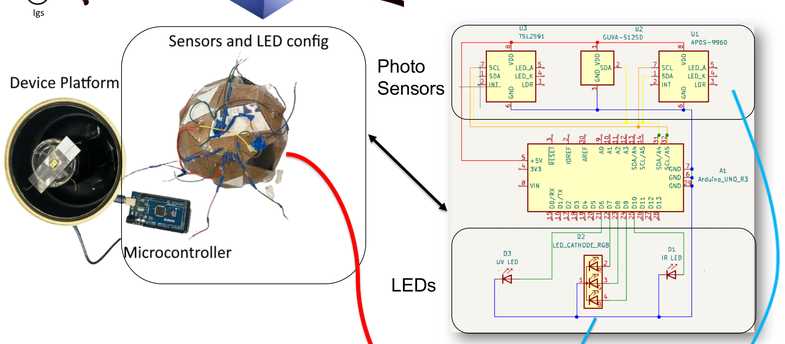
Introduction

Low-dimensional phosphorus-based nanomaterials, particularly Phosphorus Metal Halides (PMHs) single crystals, have demonstrated promising electronic and optoelectronic properties for next-generation semiconductor devices. Despite their potential, practical applications remain limited—primarily due to the lack of well-defined device architectures and insufficient studies on their behaviors under light exposure. This study aims to investigate the electronic and photo responsive properties of PMHs by developing a photo sensing device. Understanding how PMHs responds to different wavelengths of light can provide valuable insight into its potential for optoelectronic applications.

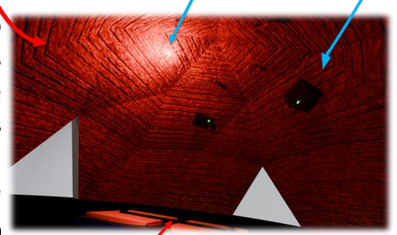
Methods

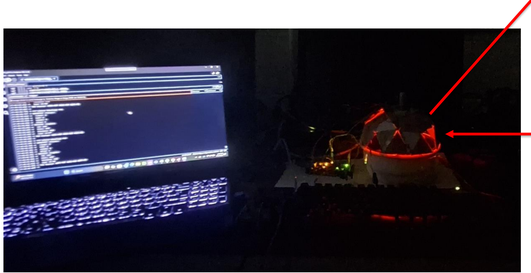


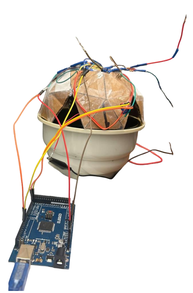
To test the photo response of the nanowire, it has to be configured in a transistor like configuration. LEDs are used to excite the nanowire.



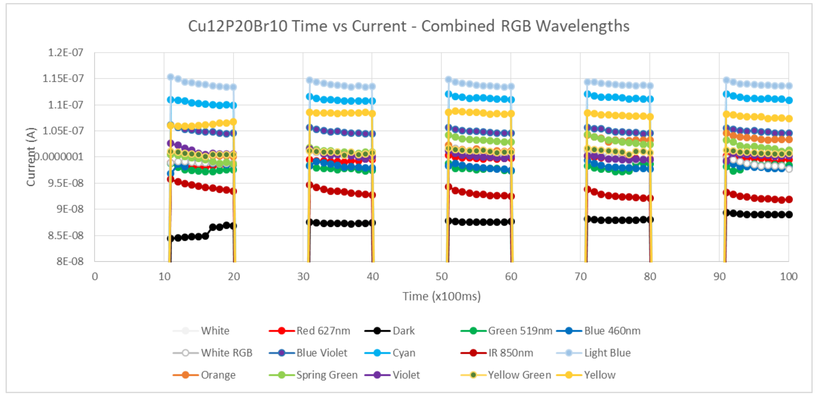
'Photomalus', a device to measure photo response was constructed to monitor the nanowires. Based on variables like Lux, IR and Color, differences between the sensibility of both $Cu_{12}P_{20}Br_{10}$ and $Cu_2P_3Br_2$ were observed.

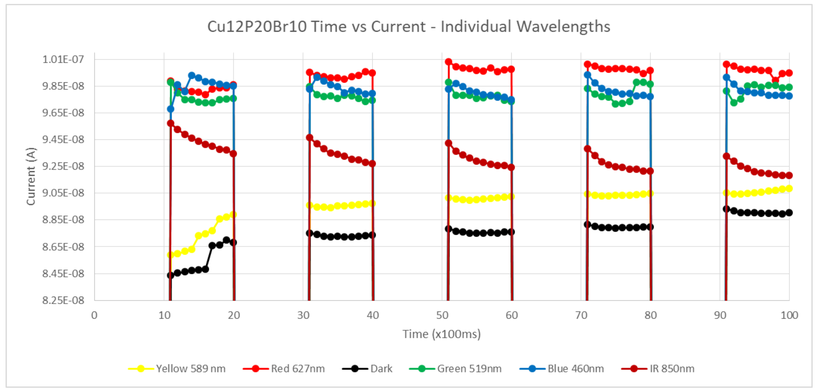


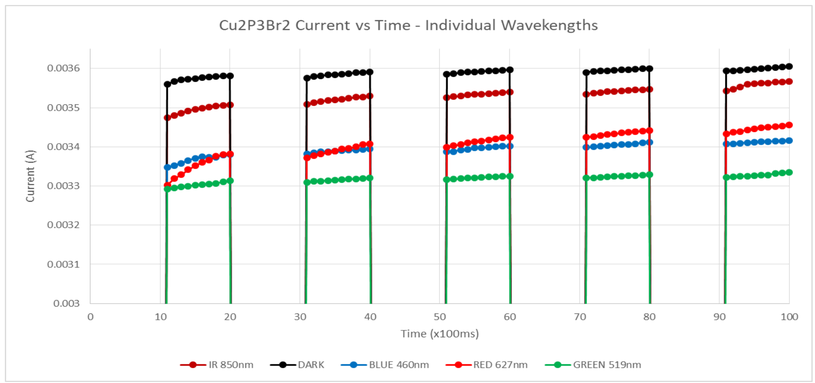


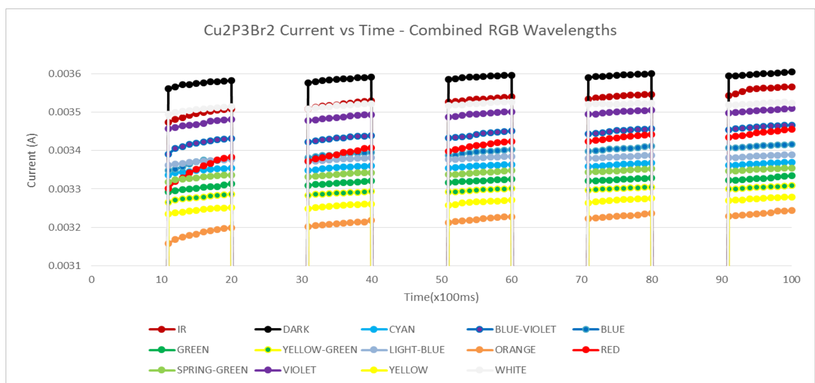


Data/Results









Discussion and Conclusion

- Successfully tested photoresponse of semiconducting nanowires despite minor challenges with Si/SiO_2 wafer bias.
- Both nanowires showed major differences in light response, with Br10 having several magnitudes lower current than Br2.
- **Br10**: Less sensitive to IR, less stable readings, but higher currents for light vs. darkness - suitable for less sensitive light systems.
- **Br2**: More responsive to IR stimuli but struggles to distinguish between visual light spectrum wavelengths.
- PMH nanowires respond to various light frequencies including infrared, with potential applications in military night vision, solar energy harvesting, and other optoelectronic systems.

Future Work

. **Enhance photodevice design:** Replace the cardboard dome with a sturdier material; improve wire organization and overall structural stability.

. **Broaden spectral range testing:** Investigate responses to a wider range of light, including full-spectrum colors, far-infrared (IR), and ultraviolet (UV) radiation.

. **Analyze response speed:** Study the sensitivity and photoresponse time of the single-wire crystal when switching between different light sources.

. **Examine intensity effects:** Investigate how varying light intensities influence the photoresponse of the single-wire device.

References

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