Design, Fabrication, and Characterization of a CMOS-Compatible Plasmonic Photodetector

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Project Code(S2.1.5)

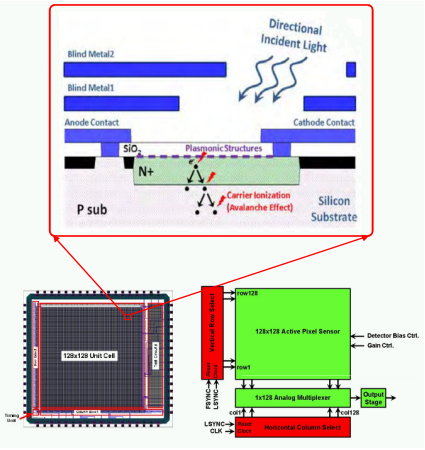
Project Overview

➢ **Project goals:**

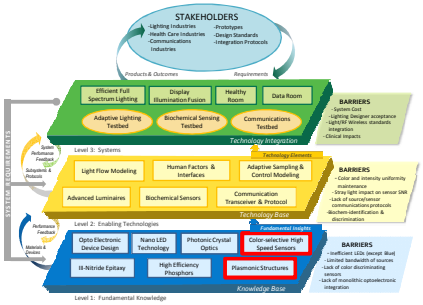
- Design and fabrication of a novel readout circuit (ROIC)
- CMOS-compatible PD array is used to be cost effective
- Incorporates nano-plasmonic technology for the sensing capability
- Avalanche photodiode (APD) structures employed to have more gain

➢ **Applications:**

- Ultra-narrowband color sensor
- Direction detection
- Visible light communication
- Adaptive lighting systems



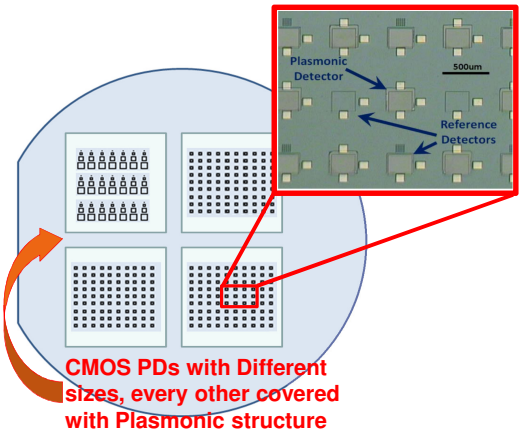
Project's ERC Role



➢ **Interactions with other ERC projects:**

- S2.1.1 Light sensors with integrated communications
- S2.1.4 Design and modeling of CMOS compatible APDs and plasmonic detectors
- T1.2.5 Improving building energy efficiency through VLC control interface

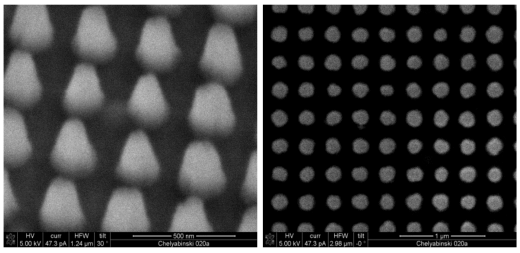
Research Results



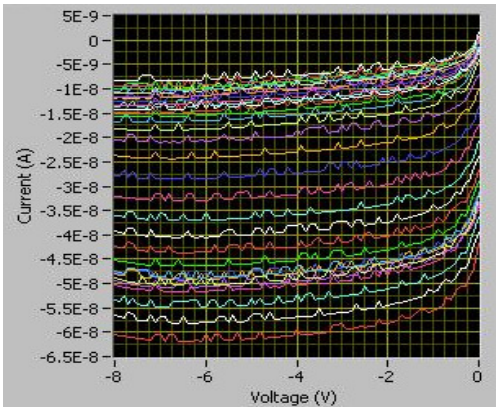
➢ Above is the wafer with shallow junction photodetectors fabricated at MTTC - UNM.

➢ Nanoparticle plasmonic structures fabricated at Prof. Brueck's lab

➢ PN junction is shallow to be more compatible with plasmonic structure on the top



➢ Picture above is SEM images of the plasmonic structure over the photodetectors



➢ Picture above shows the IV curves of a plasmonic photodiode with various light wavelengths

➢ Complete spectral response measurement is currently underway

➢ Still few issues in the process

- Need to optimize the fabrication of the plasmonic devices

Relevant Research / Products

➢ **Publications:**

- Lee, S.C., Krishna, S.; Brueck, S.R.J. "Plasmonic-Enhanced Photodetectors for Focal Plane Arrays", Photonics Technology Letters, IEEE, July15, 2011, Volume: 23 , Issue: 14, Pp: 935- 937

➢ **Products**

Spectral sensitivity	**TCS3200 from AMS/TAOS**		**Not sensitivity enough**
Directional sensitivity	**Currently, no commercial optical angle sensor in the market**		
Distance measurement	**GP2Y0A700K0F from SHARP Microelec.**		**Do not measure angular distance**
Light Intensity sensor	**MAX44009 from MAXIM**		**No color or angle detection**

Future work

➢ An interface electronic circuit is needed

- Utilize the new detector for light intensity, color, and angle detection

➢ Narrowband optical filter using plasmonic detector with spectral resolution of 20 nm

➢ Avalanche enhancement of at least 50

➢ Integrate the new plasmonic/avalanche detector into a commercial smart space

Societal Benefits

Health, Safety, and Well-being

Monitor spectrum of light to provide more healthy light to the persons in the room for the conditions e.g., time of day

- *Frequent analysis of the spectrum of light in the workplace or home*
- *Verify against approved health guidelines for lighting*

Increased Productivity

- *Healthy lighting, both in terms of spectrum and intensity, can increase individuals' productivity*
- *Outdoor lighting conditions can be mimicked in the office regardless of weather condition*

Acknowledgements

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