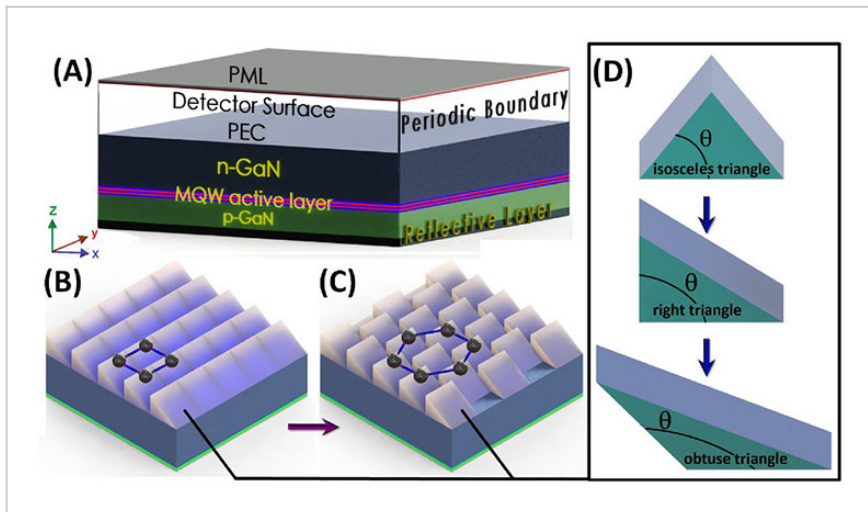


# Improved LED Light Extraction Efficiency via Substrate Microstructure

ID# 2016-4514



PennState



LED microstructure improves efficiency

## Technology Summary

LED materials have a high refractive index and a portion of the emitted light remains trapped in the active area, which lowers the light extraction efficiency. A novel method has been devised for allowing light trapped in the active area of an LED to escape, improving the efficiency of the LED with no increase in power consumption. This method employs the creation of asymmetric obtuse angle microstructures on the substrate and/or exit surface. This structure has unique features: first, with the same height-to-base aspect ratio, the asymmetric microstructured substrate has a larger surface area than that of a symmetric microstructured substrate; second, the deflection angle of the microstructured substrate is a function of location, which can increase light extraction efficiency. This new design can result in light extraction efficiencies up to 70.4% - more than 10% over current methods.

## Application & Market Utility

This technology can be broadly deployed in any application for which LEDs are currently used, including general lighting, traffic signals, camera flashes, aviation lighting, and automotive headlamp modules. Light extraction efficiency is increased up to 10% over current designs, which will ultimately result in brighter LEDs with no increase in energy usage and at a comparable cost to current LEDs. The design change can be readily incorporated into existing manufacturing processes using standard processing methods without significantly increasing manufacturing costs.

## Next Steps

Seeking research collaboration and licensing opportunities.

TECHNOLOGY READINESS LEVEL

1-3

### Seeking

Investment | Licensing | Research

### Keywords

- light emitting diode (LED)
- light extraction efficiency (LEE)
- asymmetric obtuse angles
- substrate microstructure
- microstructured exit surface

### Researchers

Shizhuo "Stuart" Yin

Professor of Electrical Engineering

[Online Bio](#)

Chang-Jiang Chen

Graduate Student

Ju-Hung Chao

Graduate Student

### Other Researchers

Wenbin Zhu

### Originating College

College of Engineering

### Office of Technology Management Contact

Yan, Bin

[byan@psu.edu](mailto:byan@psu.edu)

814-865-6277



Invent Penn State is a Commonwealth-wide initiative to spur economic development, job creation, and student career success. Invent Penn State blends entrepreneurship-focused academic programs, business startup training and incubation, funding for commercialization, and university-community collaborations to facilitate the challenging process of turning research discoveries into valuable products and services that can benefit Pennsylvanians and humankind. Learn more at [invent.psu.edu](http://invent.psu.edu).

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability or protected veteran status.