Photocoupling Design: Maximizing Light Intensity and Uniformity in Photoreactors

Relationship Between Distance and Radiant Flux

Introduction

In high-throughput photochemistry, distance from the light source directly influences light penetration, and is often overlooked. As light travels from an LED, its intensity decreases – small differences in LED-to-well distance can lead to noticeable differences in reaction performance. Many photoreactor designs position the LEDs from the reaction plate with an air gap in between, making the system vulnerable to variability.

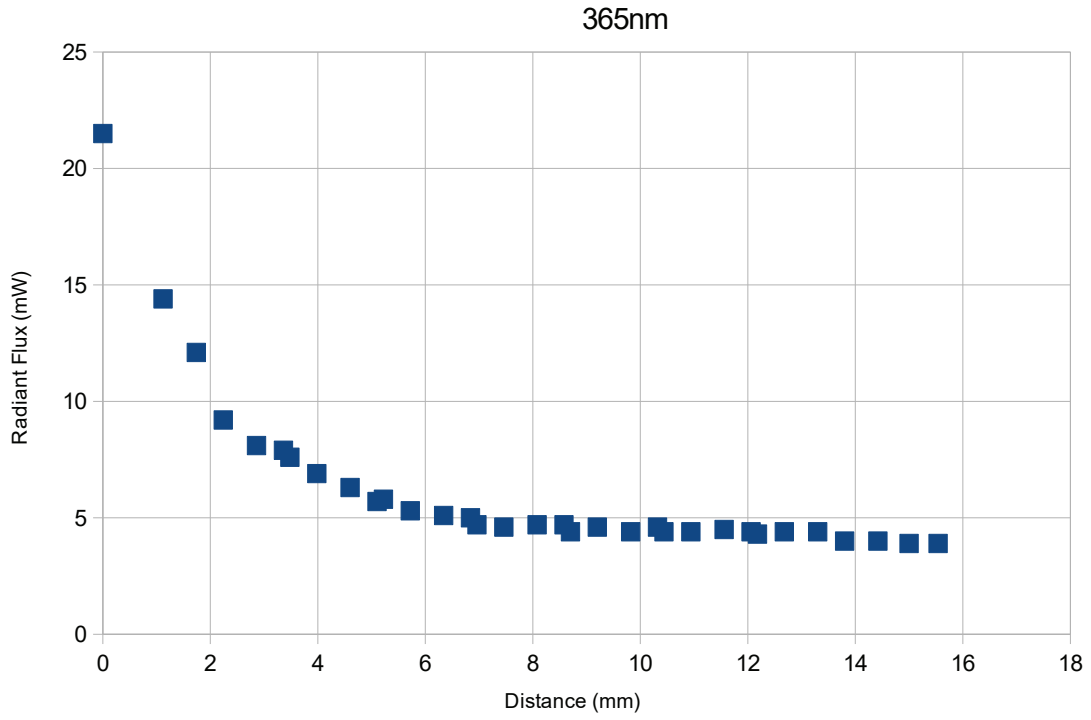
This technical note examines how light intensity changes with distance from an LED array and demonstrates how direct optical contact between the LED and reaction vessel can ensure consistent light delivery across all wells.

Methods

The radiant flux of a Lumidox® II 96-well, 365nm LED Array with Diffuse Mat and Active Cooling Base (PN: LUM296DA365) was measured at various distances from the LED surface. Radiant flux (mW) was determined using an integrating sphere and power meter.

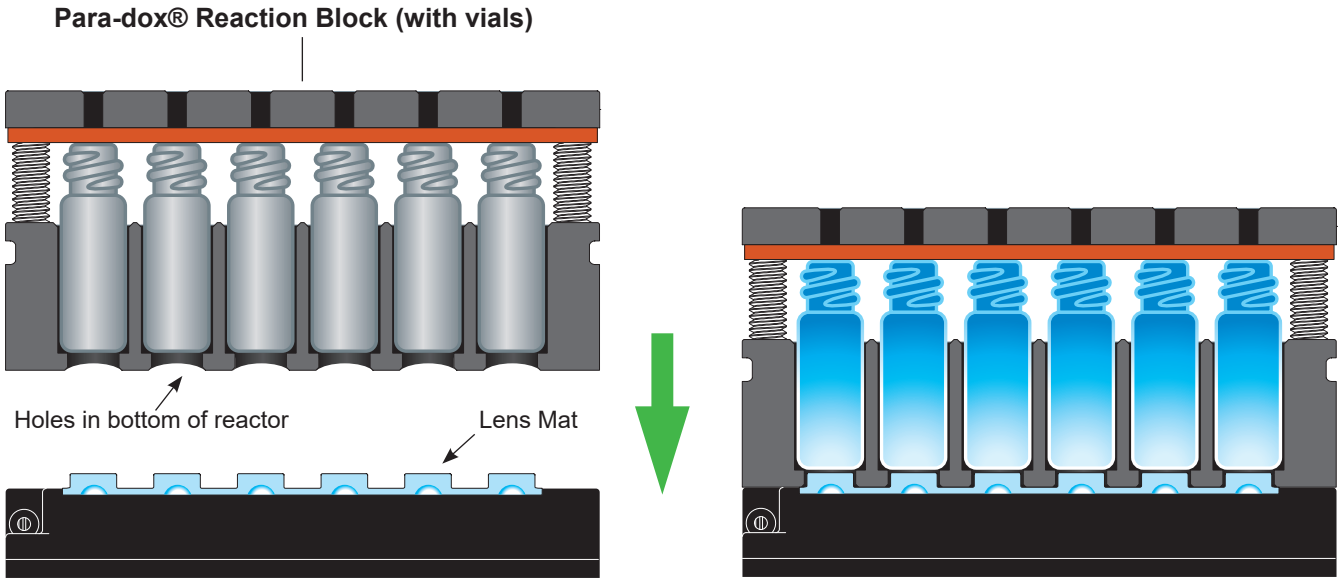
Results/Conclusion

Plot 1 shows radiant flux decreasing with distance in two distinct regimes: exponential decay at short distances (~0-6mm), followed by linear decay beyond 6mm. At distances under 6mm, small positioning changes (1-2mm) produce large flux variations, while distances beyond 6mm show more gradual, predictable changes.



Plot 1: Radiant flux (mW) as a function of distance for LUM296DA365

Without proper optical coupling, these distance variations can create significant well-to-well differences in light intensity—a critical challenge in photoreactor design. Our patented (U.S. Patented No. 11,458,447) Lumidox® II LED array with integrated lens mat addresses this by establishing consistent optical contact (optical coupling) with reaction vessels when used in a Para-dox® photoredox reaction block, effectively eliminating any air gap. This maximizes light delivery and minimizes loss, ensuring all wells receive uniform illumination.



The nubs of the lens mat fit into the holes in the bottom of the reaction block and make contact with the reaction vials (optical coupling).