



Dynamic OLEDs Connect the Automotive Lighting of Today to the Lighting of Tomorrow

John Holland, Chief Revenue Officer (CRO)

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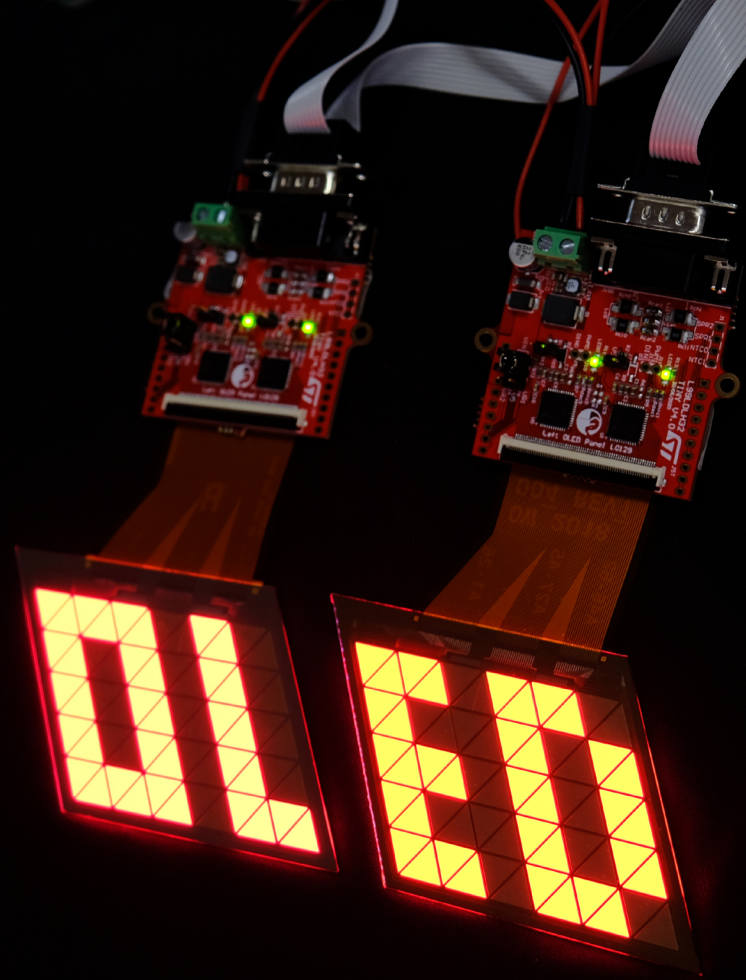


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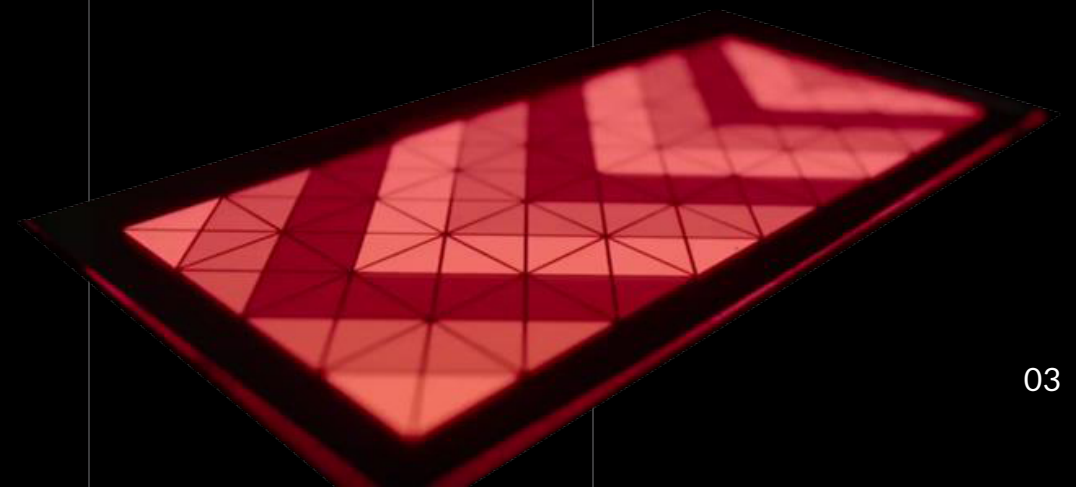
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The Future of Automotive Lighting

With the rise of electric vehicles (EVs), autonomous driving, and mobility as a service (MaaS), the automotive industry is facing an unprecedented technological revolution in the coming years. Every component and technical system will be forced to evolve to keep up with this sweeping change, including lighting technology.

In a report published by BIS Research, the authors proposed that the automotive lighting solutions of the future will possess four characteristics for success, transforming lighting from the basic objective of illumination to a comprehensive experience that will enhance the aesthetics, design, utility, and safety of the vehicle.

The Lights of the Future will be:

Because these terms can have so many different meanings with their specific nuances, here is how we define each of these characteristics.

01 Communicable

Lighting that is communicable can be used in conjunction with sensors, alarms, and other vehicle systems to provide clear communication to riders, passengers, and other vehicles.

02 Adaptive

Adaptive lighting analyzes factors such as road safety, driver information, and environment, and provides specific functions that are related to increasing the safety or personalization of the vehicle – lighting that adapts to each unique situation.

03 Ambient

Ambient lighting of the future provides an ideal illumination of a vehicle's interior with an emphasis on passenger comfort, safety, and mood.

04 Flexible

Flexible lighting is lighting freed from a two-dimensional rigid structure, expanding design freedom, integration capabilities, and the seamless marriage of lighting and vehicle architecture.

Because of its innate emission characteristics and composition, OLED lighting possesses each of these four qualities for automotive lighting success. The time for technological revolution is here, and OLED lighting is leading the way into a brighter, safer, and more individualized future.



01


OLED Segmentation Enables Communication via Light




OLED exhibits uniquely homogeneous surface emission, and due to this can be divided into lighting segments that are individually addressable through dynamic animation sequences. These animations provide automakers with the tools necessary to develop novel communication capabilities with and between other cars, the driver, and passengers - commonly referred to as "Car-to-X" communication.

In conjunction with digital sensors and other intelligent vehicle systems, OLED lighting technology can communicate upcoming hazards and sudden changes in speed or road conditions. Communicable OLED lighting can be utilized in the rear of the car or within the vehicle's interior to give warnings to the driver.


Increased segmentation for:




Improved road



Enhanced design




Interactive




Warning information
i.e. unsafe road conditions

Our first generation



4 to 6 segments

today's panels



50 segments within 25/sq centimeters

The first generation of OLED lighting panels only had around 4 to 6 segments. The panels being manufactured for vehicles today contain over 50 segments within an area of about 25 square centimeters, and our team continues to develop increased segment counts for future models. This opens the door for innovative design and communication options.

Adaptive OLED Systems Increase Safety and Personalization

Adaptive lighting can be split into two primary functions: safety, and personalization.

Many new cars already include an adaptive front lighting system which adjusts headlight brightness depending on different road and driving conditions. This same safety functionality can apply to adaptive rear lighting, where a sensor measures visibility conditions and modulates the intensity of the light, providing the correct brightness and signaling according to need.

Additionally, adaptive rear lighting systems can help prevent collisions. For example, if the driver of a vehicle with segmented OLED rear lighting experiences slippery or icy road conditions, the panel can flash a symbol such as a snowflake to alert the driver in the vehicle behind them. Dynamic indicators have been shown to catch attention quicker than a simple illumination like what is found in typical brake lights.

Another application that can increase safety through the dynamic segmentation of OLED

lighting is through integration into the CHMSL (Center High Mounted Stop Light). With their thin and flexible form factor and crisp segmentation, OLED lighting offers a unique design opportunity in this area through new designs, weight and space savings, and logo branding capabilities. There are even current projects examining the feasibility of adding OLED lighting between layers of laminated glass in the rear windscreen of vehicles – an entirely new take on the CHMSL. Beyond safety, adaptive lighting will allow drivers and passengers to customize the vehicle lighting to their preferences. In the future, this can take the form of connectivity between a smartphone and the car's interface which controls the lighting levels or choose which lighting signatures they prefer upon leaving and entering their vehicle. This creates a deeper connection between the vehicle and the driver, and the segmentation and 0-100 dimming range of OLED lighting offers many options for manufacturers to provide to their customers.



In the end, you want to make your car your car. The same way you're going to choose the lacquer, the same way you choose the color of your seats, you want to have something which is individual...Why not get the chance to change something which is fulfilling your wish?"

– Dr. Michael Kruppa, Audi AG



Interior Lighting is More Functional and Comfortable with OLEDs

The ambient lighting of today goes beyond simple illumination. It gives the driver a sense of orientation and spaciousness as well as feelings of safety, comfort, and even a sense of luxury. According to automotive manufacturers, proper ambient lighting delivers an emotional atmosphere that connects drivers and passengers with the comfortable created environment within their vehicle.

In the future, an increasing combination of functional and emotional aspects of lighting is expected to be extraordinarily important as autonomous driving continues to expand and improve. Drivers will essentially become passengers within their own cars and will look for additional comforts to make their ride as relaxing and enjoyable as possible.

OLED lighting in automotive interiors is a differentiator because its illumination is naturally diffuse and homogenous. It provides an ambiance that significantly impacts the perception of the interior space and overall driver experience, including increased comfort and orientation inside the vehicle during dusk and nighttime driving.

Engineers from BMW and the Lighting Engineering Group at the Ilmenau University of Technology found that substandard forms of

interior lighting decrease driver safety. These light sources create uncomfortable glare leading to distractions, driver mistakes, and accidents.

OLED, on the other hand, provides a safe and comfortable balance of brightness and reduced glare while:

01 Enhancing spatial awareness		
	02 Minimizing exhaustion	
		03 Improving the overall driver and passenger experience
	04 Making vehicle controls easier to use	
05 Providing a more visually pleasing result		



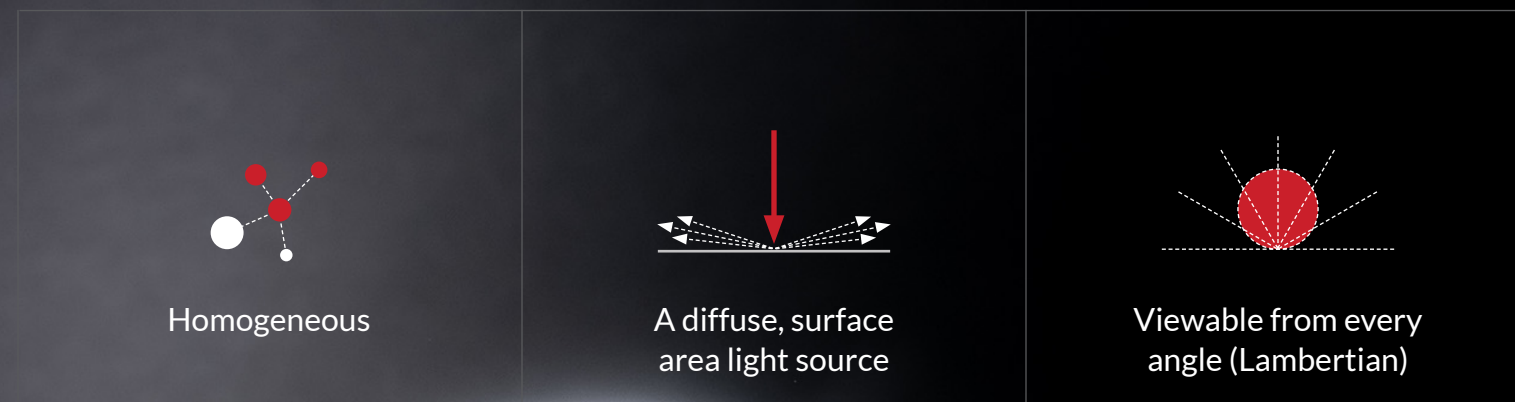
Interior Lighting is More Functional and Comfortable with OLEDs

OLEDs also provide vast possibilities for ambient in-car lighting to accentuate brand and personality. Effectively 'flat' light sources, OLEDs do not need any reflectors, light guides, or other optics, which makes them extremely efficient and lightweight. As they can be designed in any shape and fitted to a flexible carrier, they provide even greater flexibility for integration than LEDs, providing new opportunities for logo integration and unique brand differentiation.

When sensors detect a safety issue, OLEDs can quickly transition from ambient lighting to safety warnings. For example, if sensors detect driver fatigue or a hazardous situation on the road, lights within the vehicle could automatically increase to maximum brightness or flash in a strobing effect to alert the driver.

With OLED segmentation, car manufacturers have additional options for alerting the driver, including attention-grabbing symbols, shapes, and various dynamic light animations. With segmented OLED lighting, manufacturers have a way to communicate relevant information to drivers without the need for a separate display.

OLED lighting is perfect for high contrast segmentation as it is naturally:





04

Lighting Design in 3D - Flexible OLED Lighting

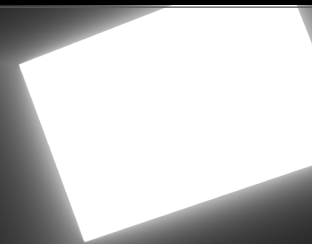

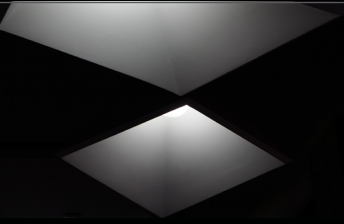
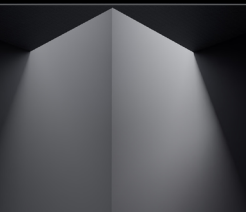
OLED lighting is highly customizable, can project light in ways LED lighting cannot, and allows for vastly improved aesthetics through distinctive design and brand differentiation options. One unique characteristic that automotive designers are particularly eager to take advantage of is flexible OLED panels.

Flexible OLEDs open many exciting new opportunities for automotive OLED lighting, allowing automotive designers to curve the lighting around the radius of the vehicle's rear corners.

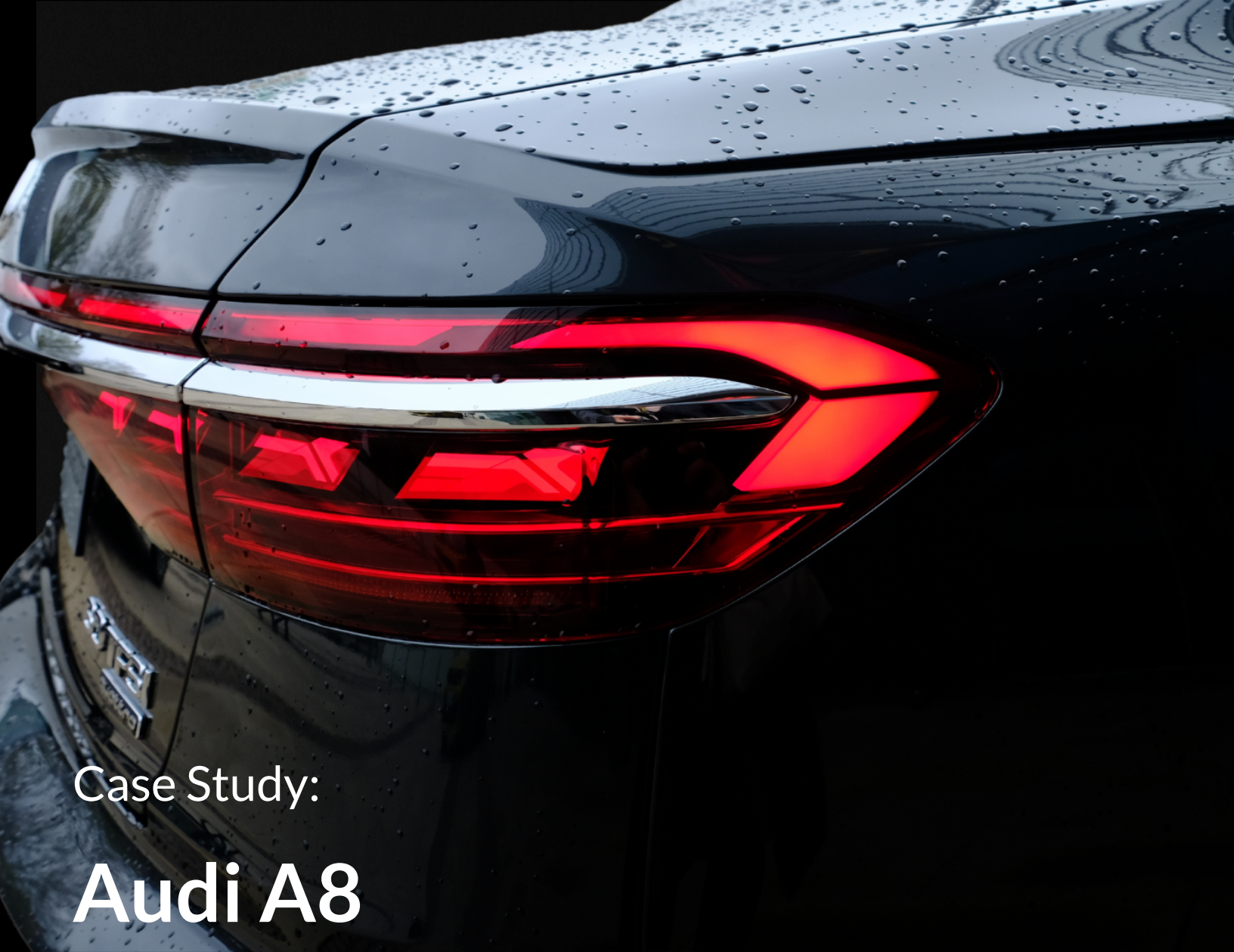
Just think of the possibilities: all the same amazing benefits of OLED lighting (comfortable, diffuse, ultra-thin, cool to the touch) within a new, innovative, flexible glass format.



This flexibility provides improved:

<p>01</p>  <p>Viewing angle</p>	
	<p>02</p>  <p>Space savings</p>
<p>03</p>  <p>Branding capabilities</p>	
	<p>04</p>  <p>Design freedom, safety, and 3D light sculpture</p>

3D options with OLEDs require no additional reflectors or optics to ensure the light can be seen from any viewing angle and have the potential to give car manufacturers a completely new approach to lighting design.









Case Study:
Audi A8

In April 2022, OLEDWorks announced that it is the official supplier of OLED lighting panels for the updated Audi A8. OLED rear lighting is a standard feature in this model and allows customers to personalize their vehicle with up to four different light signatures across the model range.






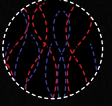
The first vehicle to offer OLED lighting standard, and the lights increase safety on the road through proximity indication and a wide viewing angle.

Future vehicles that incorporate OLED lighting technology are currently in development and will include an increased segment count, brightness, and overall performance.

A8 OLED Panel Tech Specs:

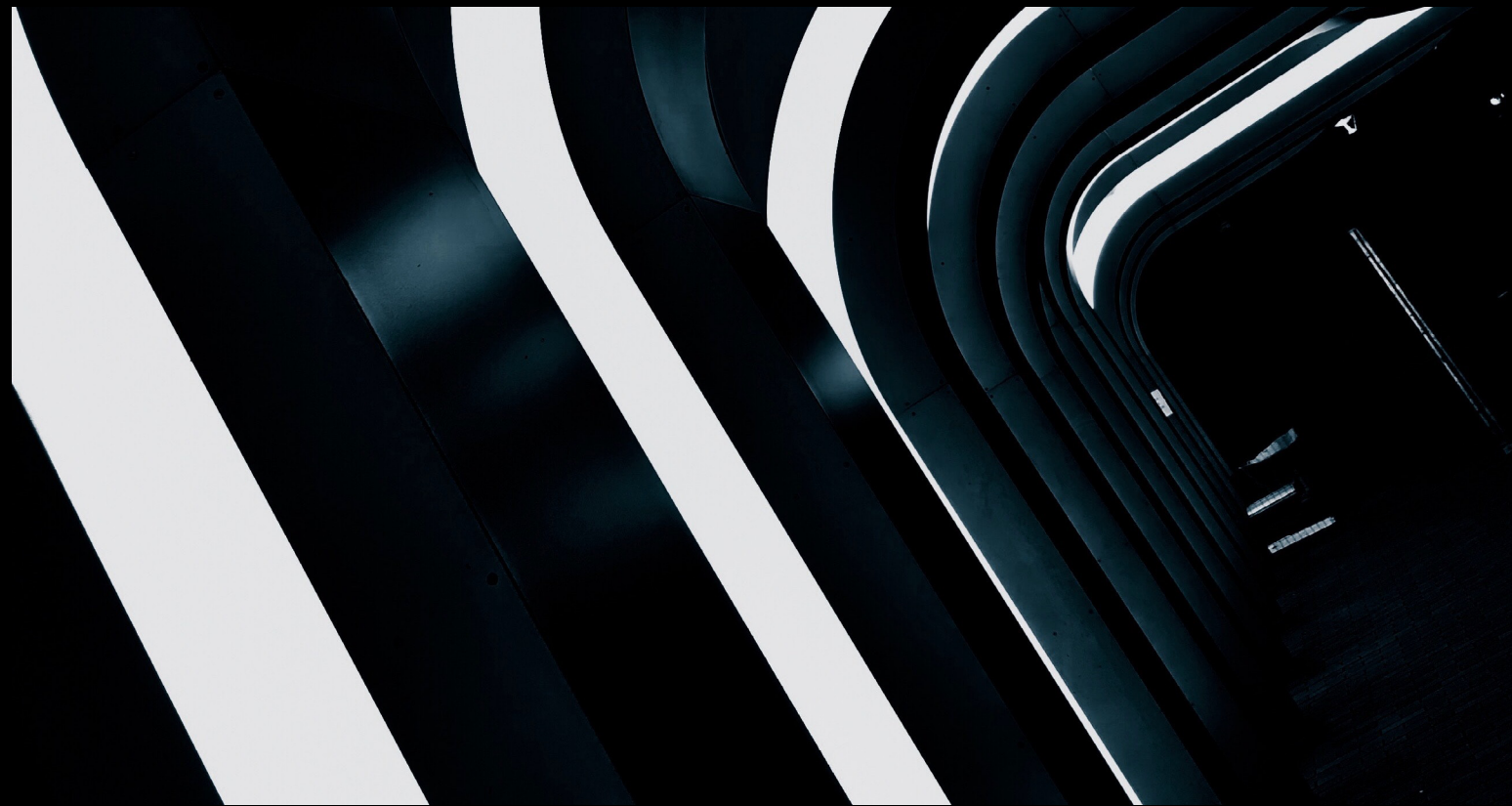
 Lifetime Designed to last the life of the vehicle	 Brightness 2000 cd/m ²	 Color Deep Red (ECE/SAE qualified)
 # of Segments 6	 Mirror Reflectivity Less than 90%	 Dimmable 0 - 100% dimmable across the whole surface

Environmental Validation

 High temperature and humidity storage and operation (up to 85C/85%RH)	 -40°C Low temperature operation (down to -40°C)	 105°C High temperature storage (up to 105°C)
 Thermal shock (-40°C/85°C)	 Mechanical shock and vibration	 Corrosive gas and electrostatic discharge

Process

The OLED Design & Production Process



When developing custom automotive lighting solutions, our approach at OLEDWorks is to work in tandem with Tier 1 suppliers and OEMs, offering support and input at each stage of the development process to save money, resources, and headaches. We've outlined details of a typical development process below so that you know what to expect when you meet with our team.

All production details are subject to change depending on any additional steps, work, or testing required of complex projects.



01 Design Kick-Off

Customer presents their intended design and styling for the panel, including panel shape, size, and segmentation layout. This design is refined to follow OW design rules and optimized for manufacturing.

02 Design Verification

Customer presents their intended design and styling for the panel, including panel shape, size, and segmentation layout. This design is refined to follow OW design rules and optimized for manufacturing.

03 Design to Customer for Inspection / Verification

Panels are sent to the customer, and the customer confirms the design meets their criteria.

06 Car

Start of car production.

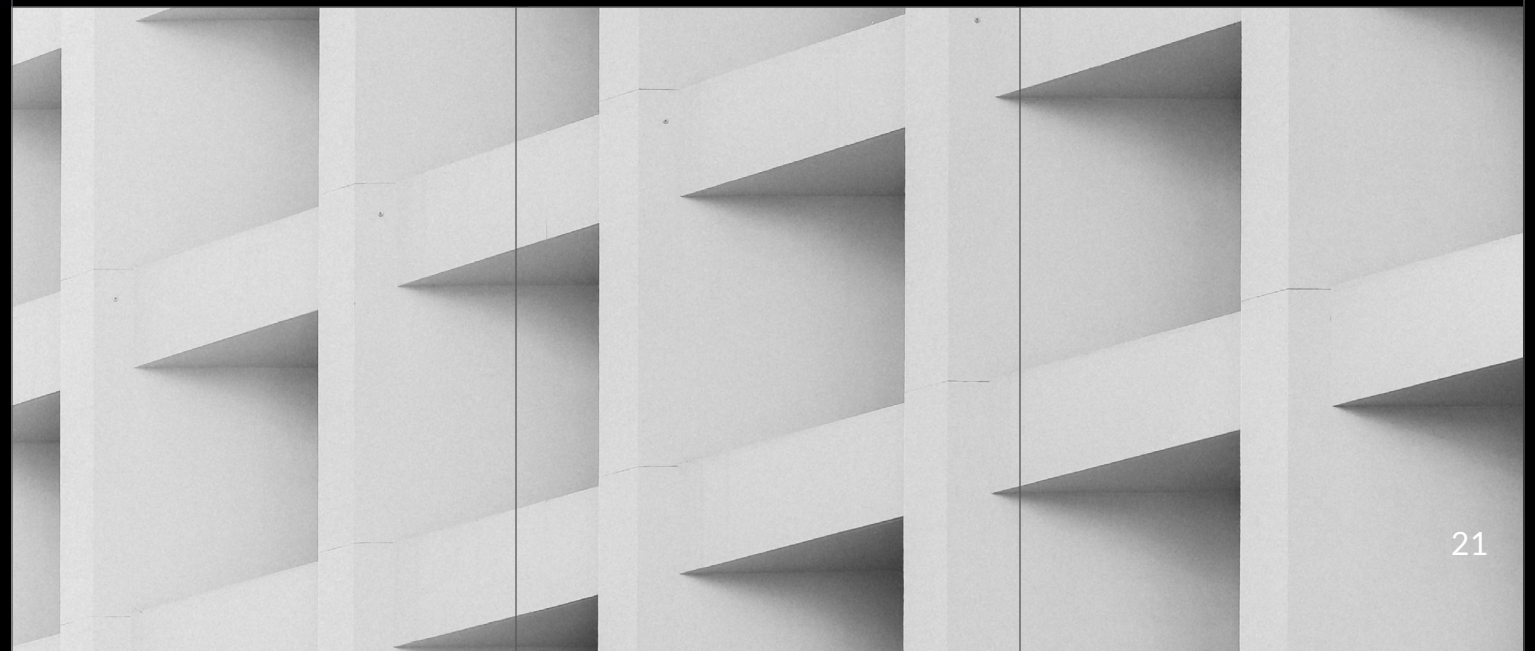


05 OLED Panel PPAP Complete

Customer presents their intended design and styling for the panel, including panel shape, size, and segmentation layout. This design is refined to follow OW design rules and optimized for manufacturing.

04 C-Sample Production

This is the start of panel production for the car SOP. This includes finalizing the design, production of the panel on the OLEDWorks line, and environmental testing.





The OLEDWorks Joint Development Program

The Joint Development Program offers OEMs and Tier 1s the opportunity to evaluate and prototype real-world OLED applications; develop engineering mindshare; and serves as a launching pad for commercialization of OLED solutions for future SOPs.

- ✓ Accelerated development track with a defined timeline
- ✓ Access to top OLEDWorks engineers
- ✓ Ongoing educational support for internal teams
- ✓ Cost-sharing for development of prototype/demonstrator



Learn More about the Program

<https://www.oledworks.com/who-we-serve/automotive>



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