



# *OLED Lighting*

## For Automotive Solutions



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# Introduction

A car is not just a tool to move you from one place to another. A car can be a statement, a symbol of freedom, a way to achieve personal independence, an extension of one's personality. With each new generation, cars continue to adopt the latest technologies in their efforts to differentiate themselves in the market and increase safety.

Today, lighting is a major part of the brand signature for every manufacturer and for each of their cars. But lighting also plays a significant role in increasing safety for drivers and those around them. From enhanced indicator lights to dynamic rear lights, automotive lighting is evolving to keep us safe through better and more effective signals and communication. The next step in that evolution is OLED lighting for automotive applications.

**"The most important thing is to have a unique homogeneous illumination on the surface. The big disadvantage of an LED is it's a point light source. It's a lovely technology for everything you want to project on the front of your car. But in the rear of the car, you really want to have some kind like a display."**

*Dr. Michael Kruppa, Audi*



*OLED rear lighting concept*

# The Evolution of Automotive Lighting

## Today's Automotive Lighting Solutions

Designing with light is now ubiquitous throughout the automotive industry, with different types and generations of cars having distinct front and rear lights. The exterior light expression creates the individual look of the car, while also having the greatest impact on safety for the driver. One of the most common examples of lighting that promotes road safety are LEDs at the front of vehicles, including daytime-running lights and headlights where the intrinsic high intensity point source nature of LEDs is an advantage for visibility. Although LEDs were first used in taillights, the point source nature of LEDs constrained the designer to produce taillights that were inherently non-uniform; initially uniformity was not required, so this was acceptable. But now, designers and engineers are realizing that when uniformity is achieved, taillights can perform at higher levels and further increase our safety.

## The Future of Automotive Lighting

The taillight of the future will enable a communication function more akin to displays than traditional taillight solutions. Taillights with uniform, homogeneous surface illumination, with individually controllable and crisply defined segments with high contrast ratio are required to enable this type of communication. Organic light emitting diodes (OLEDs) are the ideal light source for achieving this high level of performance.

This type of performance is not well suited to the application of LEDs or other traditional lighting methods. Optical methods required to spread and diffuse emission from the LED point sources add bulk to the lighting system, reduce energy efficiency, and blur individual segments of the taillights into indistinct fuzzy zones. This fuzziness prevents the level of communication desired.

# The Benefits of OLED Lighting

## Homogeneous Surface Emission

The structure of an OLED emits light from the entire surface of the panel, creating a perfectly homogeneous surface emission with no hotspots.

## Individually Addressable Segmentation

Because of their homogeneous surface illumination, OLED lighting can create individually addressable segments with high contrast and minimal crosstalk for superior communication.

## Slim Profile

The organic layers of an Organic LED are as thin as a human hair, and even with the glass substrate and additional components, the entire thickness of the panel is less than 2mm.

## Lightweight

The thin profile and components of an OLED panel mean it is light, reducing the overall system weight and consequently, fuel consumption.

## Low Heat Output

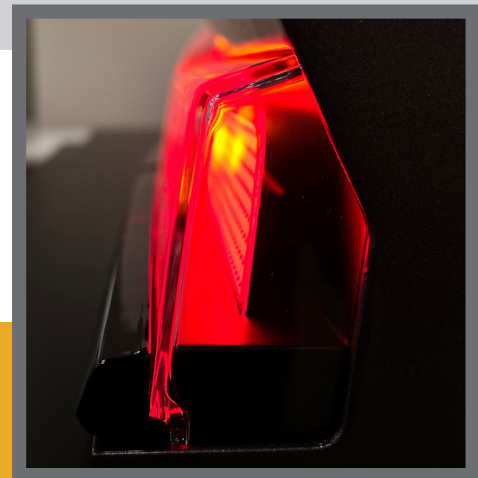
Because the entire surface of the OLED is the emission area, the heat is spread out evenly across the panel such that localized hotspots do not occur.

## System Simplicity

Because of their naturally diffuse nature, homogeneous emission, and low heat output, OLEDs do not require additional components such as heatsinks or diffusers.



*OLED rear lighting concept*



*Thin profile of an OLED lighting panel*

# OLEDs for Exterior Automotive Solutions

The uniform surface emission and capability for high contrast segmentation of OLED lighting technology makes it the ideal choice for taillight applications. With its homogeneous nature, OLED lighting provides clear illumination without producing harsh point light in a singular direction. OLED panels can also be designed to have multiple, individually addressable and dimmable segments providing high contrast ratio between segments without crosstalk. This is achieved within the panel design and does not diminish the thinness, uniformity, or quality of the light. Segmentation allows for possibilities ranging from increased safety by notifying surrounding passengers and vehicles that there is an obstruction in the road or a hazard ahead, to design differentiation including customizable turn signal patterning for your vehicle. The factors that make OLEDs the ideal choice for taillights make them equally well-suited for other rear lighting solutions, including brake lighting and turning signals, where the thin form factor and capability for segmentation brings additional design possibilities and functionality. OLED lighting technology in these areas has seen significant interest, and is also being explored for future applications.

**"OLED, at the moment is perfect. It's the only [taillight solution] where we can get the [desired] intensity, we get a nice look, and we can do all of this."** *Stephan Berlitz, Audi*



*Digital OLED demonstrator by Audi*

# OLEDs for Interior Automotive Solutions

Organic LEDs enhance the safety of drivers and pedestrians through superior rear lighting performance. But they also offer health and sustainability advantages that can be applied to a vehicle's interior. Interior OLED lighting solutions carry the same benefits as rear exterior solutions like space reduction, weight reduction, and efficiency. In addition, the diffuse nature of OLEDs means that they are virtually glare-free and create a comfortable and soft lighting experience. OLED lighting has no UV light output which can be damaging to eyes and skin, and has been rated as exempt of photobiological risk by the IEC, making it a healthy lighting solution for placement close to the user.



# Sustainability

In addition to its exceptional performance and lighting quality, OLED lighting has many sustainability advantages. In addition to being free of any toxic metals, OLED lighting is energy efficient and does not lose any efficiency in the system due to the use of additional optical components like diffusers or thermal heat sinks. According to a lifecycle analysis by the Department of Energy, thermal heat sinks often have the highest environmental impact in the manufacturing and disposal steps related to inorganic LED lighting. Because of their thin profile, OLEDs also save space and decrease the overall weight of the taillight system, reducing fuel consumption.

Our partners estimate that replacing LED technology in the taillight with OLED technology would result in:

**80%** space reduction

**50%** reduction in taillight weight

**25%** reduction in overall cost

Due to few panel components and the use of non-toxic materials, OLEDs have a reduced manufacturing footprint and easier end-of-life recycling.

## Design Benefits

Due to form factor and function, OLED lighting provides the design freedom to optimize total system performance for energy consumption and other factors associated with greenhouse gas emission:

- Reduced lighting system weight in vehicles allows improved fuel efficiencies and reduced emissions
- Fewer lighting fixture components and use of non-toxic materials results in a reduced manufacturing footprint and easier recycling at the end of the lifecycle

# Commercial Readiness

Not long ago, the thought was that OLED lighting could be a potential competitor for future lighting solutions, but that it was not yet ready for widespread commercial adoption. But in the last five years alone, OLED lighting efficacy has doubled, and lifetimes have tripled. OLED is here, and is a competitive lighting option.

You can already find OLED lighting technology being used for rear taillighting solutions in Audi models such as the 2018 A8 and the 2021 SQ5, with additional OLED lighting prototypes presented at tradeshow for future generations of vehicles. OLED lighting technology has had to undergo extensive testing to meet the rigorous automotive lighting standards and continues to pass with flying colors.



*Digital OLED demonstrator by Audi*

**"We have 3,500 hours [at 85°C, 85% RH], so this is climatic conditions you find in the tropic forest. So, we are really trying to squeeze out the maximum of these parts. They don't fail. So in the end what you can see here is really serious quality, serious production, and we can apply this to any kind of car."**

*Dr. Michael Kruppa, Audi*

## Automotive Reliability Testing

OLEDWorks red taillight panels have undergone and passed extensive automotive reliability testing, following guidance from AEC-Q-102 standards.

### Tests include:

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



# OLEDs and Other Forms of Transportation

While the automotive sector was one of the first transportation markets to adopt OLED lighting technology, the benefits of OLED lighting that make it appealing to automotive applications easily transfer to other modes of transportation.

## Aerospace & Rail Today

Design and engineering of the interior cabin of trains or planes is a balancing act between optimizing space, managing operation and maintenance costs, meeting safety and regulation requirements, and prioritizing passenger comfort. Lighting technology can play a critical role for many of these factors. Current fixtures in aerospace and rail are often recessed lighting with uneven, high-glare illumination that can put strain on the eyes. Fixture bulk can limit placement options and add unwanted weight, resulting in extra fuel consumption.



*OLED lighting in the Aeroliner 3000,  
recipient of the 2017 Red Dot:  
Design Concept award*

## OLED Lighting for Aerospace & Rail

OLED lighting can address many of the design challenges found in the train and plane cabin environment. With ultra-thin and lightweight profiles, high efficacy, and long lifetimes, OLED panels offer weight reduction and low power consumption to help manage operation and maintenance costs. The compact nature of OLED lighting, when combined with the glare-free, diffuse illumination from the panel, gives flexibility for integration on horizontal and vertical surfaces and compact spaces, providing more design freedom to optimize cabin lighting for passenger comfort. The inherent surface illumination of OLED lighting technology also provides the ability to selectively address certain segments of the panel with high contrast, which enables the ability to communicate with passengers or crew via light for safety and branding purposes.

## Recreational Vehicles (RVs) Today

Take a look at the inside of recreational vehicles (RVs) these days, and you'll find the interiors increasingly incorporate the comforts of home. From open kitchen areas with quality material cabinets and countertops, to more spacious, reconfigurable floor plans with Wi-Fi systems and smart controls, these vehicles are designed with comfort in mind. Larger windows that allow more natural light are also trending, but indoor lighting for evening and nighttime, which is often recessed for space savings and modularity, can be dim, specular, and exhibit high levels of glare, all of which can contribute to eye strain and fatigue. Heat generation from the lighting system can also be an issue with RVs if older technologies such as incandescent bulbs are used.



*Interior of a luxury RV*



*OLED lighting concept for RV fixtures*

## OLED Lighting for Recreational Vehicles

The naturally diffuse, uniform, low-glare illumination that OLED panels offer is ideal for RV indoor lighting. The panels are thin, lightweight, and compact, which gives manufacturers greater flexibility in their design and placement within the unit, to optimize the overall lighting experience. OLED lighting contains no UV light presenting no photobiological risk to the skin and eyes. OLED lighting is also low maintenance with long operational lifetimes, so owners do not get surprised with failures or have the inconvenience of carrying around replacement units. OLED panels produce a soft illumination that contains very low levels of circadian blue light, which is ideal for evenings, as these wavelengths can suppress melatonin production, which disrupts sleeps, and interfere with other nighttime disease-fighting biochemistry processes in the body. The lack of UV and short blue wavelength content, which has been shown scientifically to lure many varieties of insects, is also ideal for minimizing attraction of these insects to the interior of the vehicle.

# Additional Resources

This eBook has a lot of information, but can't answer every question on the merits of OLED lighting for automotive lighting solutions. Below are some additional resources for you to learn more.

## Connect with an OLEDWorks Sales Partner

Do you work in the automotive or transportation industry and see an opportunity for OLED lighting in your vehicles? Set a meeting with a member of our team to discuss how we can work together and make that vision a reality.

**[Speak with a member of our team](#)**

## OLEDWorks University Virtual Automotive Course

OLEDWorks University was founded as a resource for professionals looking to expand their knowledge of OLED lighting technology and its applications through virtual courses. "OLED Lighting for the Next Generation of Automotives" is developed and taught by our OLED engineering experts and offers a technical look at the benefits OLEDs provide through current and emerging automotive applications.

**[Reach out to our team to schedule your course](#)**

## Subscribe to the OLEDWorks blog

The OLEDWorks blog is the best place to learn about advancements in OLED lighting technology, new products, industry studies, whitepapers, eBooks, and more.

**[Subscribe to the OLEDWorks blog to be the first notified of any new content](#)**

## OLEDLight.org

OLEDLight.org was founded by a group of OLED trailblazers to serve as an educational resource, driving awareness for the merits of OLED lighting.

**[Explore OLEDLight.org to learn more](#)**