



# Mono-material Headlamp Concept

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# Agenda



## I. Introduction

Headlamp **Concept** system, features, economics

## II. Quick View of Case Study

Reflective Heat Sink

LED Fog Lamp

Sensor Transparent Bezel



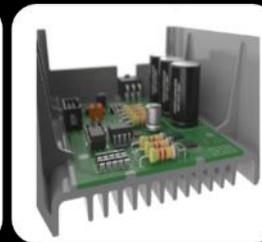
*Materials*



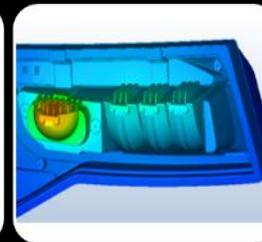
*Sensor  
Integration*



*Consolidated  
Assemblies*



*Reduced Mfg  
Complexity*



*Heat  
Management*



*Sustainability*

# Our polycarbonates portfolio

Our four main product lines in automotive industry



## Makrolon®

Transparency, high heat and high impact  
(PC)



## Apec®

Transparency, higher heat resistance  
(HH PC)



## Bayblend®

Good balance of high flow, impact strength and chemical resistance  
(PC+ABS; PC+ASA )



## Makroblend®

High toughness, chemical resistance, low temperature ductility  
(PC+PBT; PC+PET)



# Pushing boundaries for more than 50 years

Supporting developments in the automotive industry with innovative products



1967



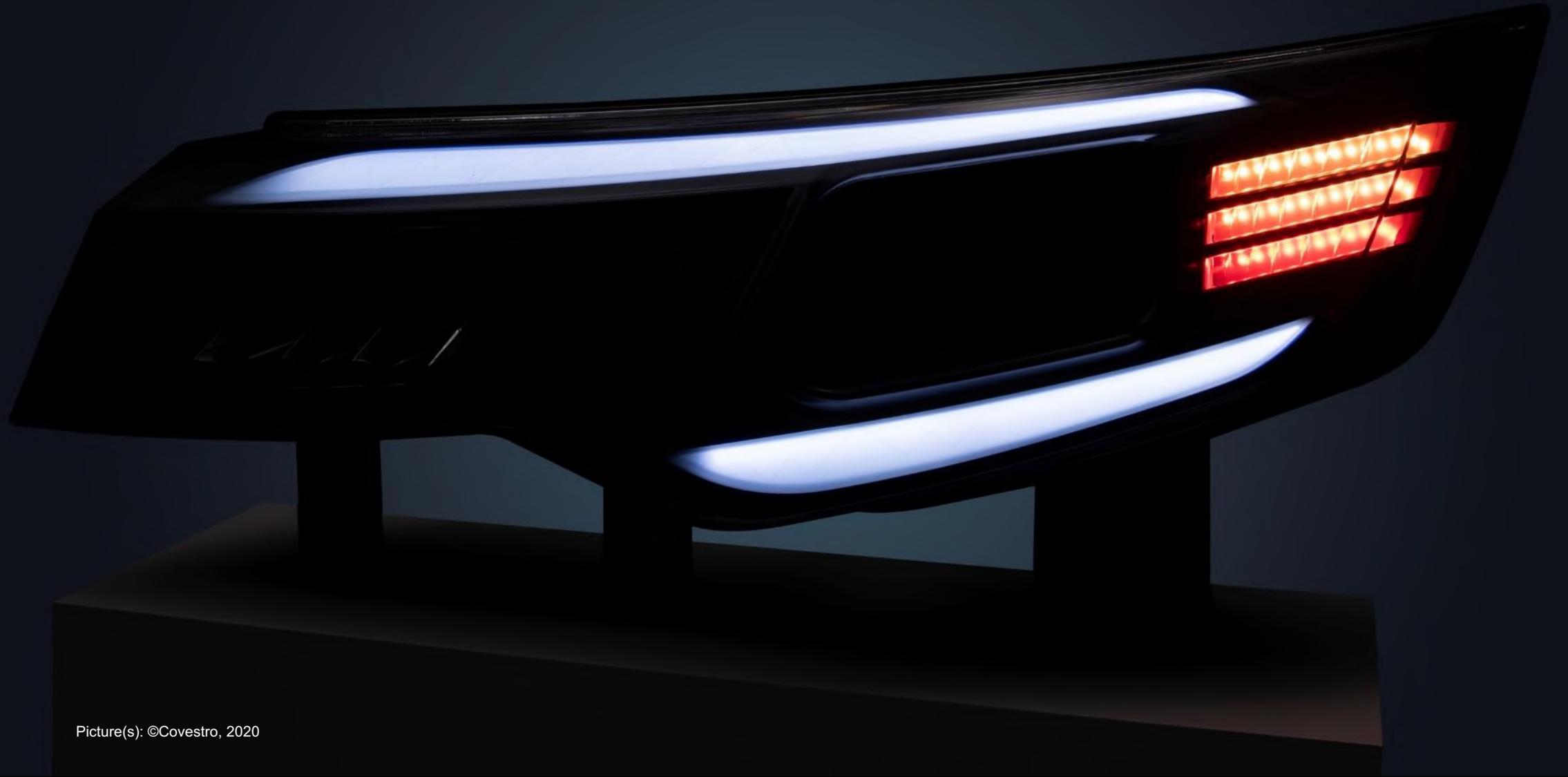
2016



park lights



turn signals



high-beam styling ring / bezel



low-beam



high-beam







# Mono-material Headlamp System

Novel headlamp system that's exclusively polycarbonate-based



Outer lens cover

3K Bezel

3K Reflector/Housing

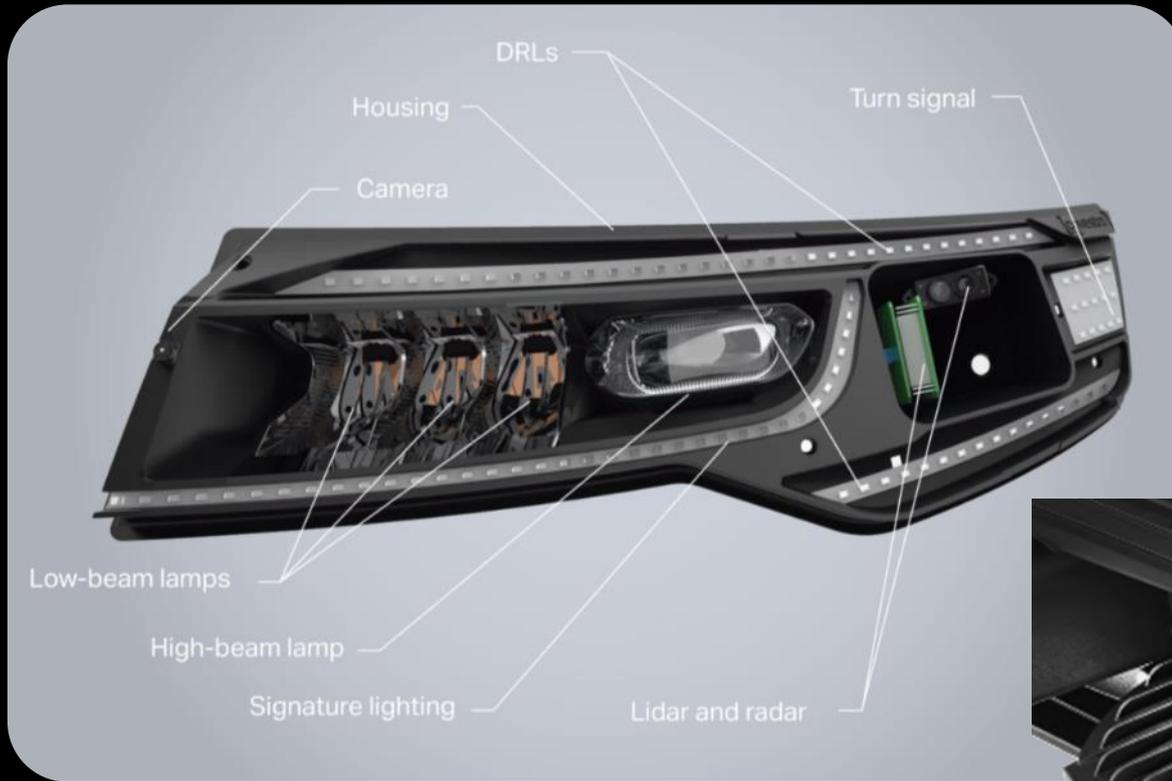
High-beam collimator lens  
High-beam styling ring / bezel

- Heat sinks are integral to the housing
- Bezel combines lidar transparency with diffuse lighting
- In-mold electronics – LED PCBs
- Sensor integration – lidar, radar, camera
- Laser welded outer lens cover to the housing
- Aesthetic options – progressive color, lighting, texture
  
- Cost ~ \$ 4.50 savings per headlamp
- Weight ~ 1.8 kg saved per headlamp
- Space ~ 2-3 cm thinner headlamp
- Sustainability – less is more
  - easier recycling, single material stream, fewer parts
  - fewer manufacturing operations, tools & fixtures

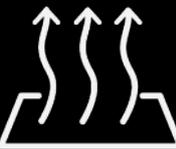
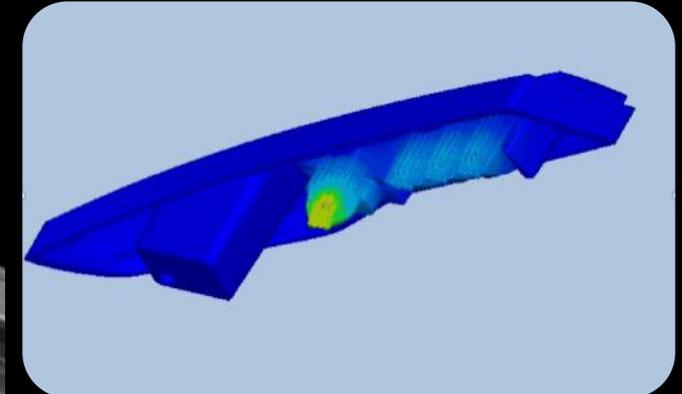
# Housing



All heat generating elements are mounted into or on the thermally conductive housing

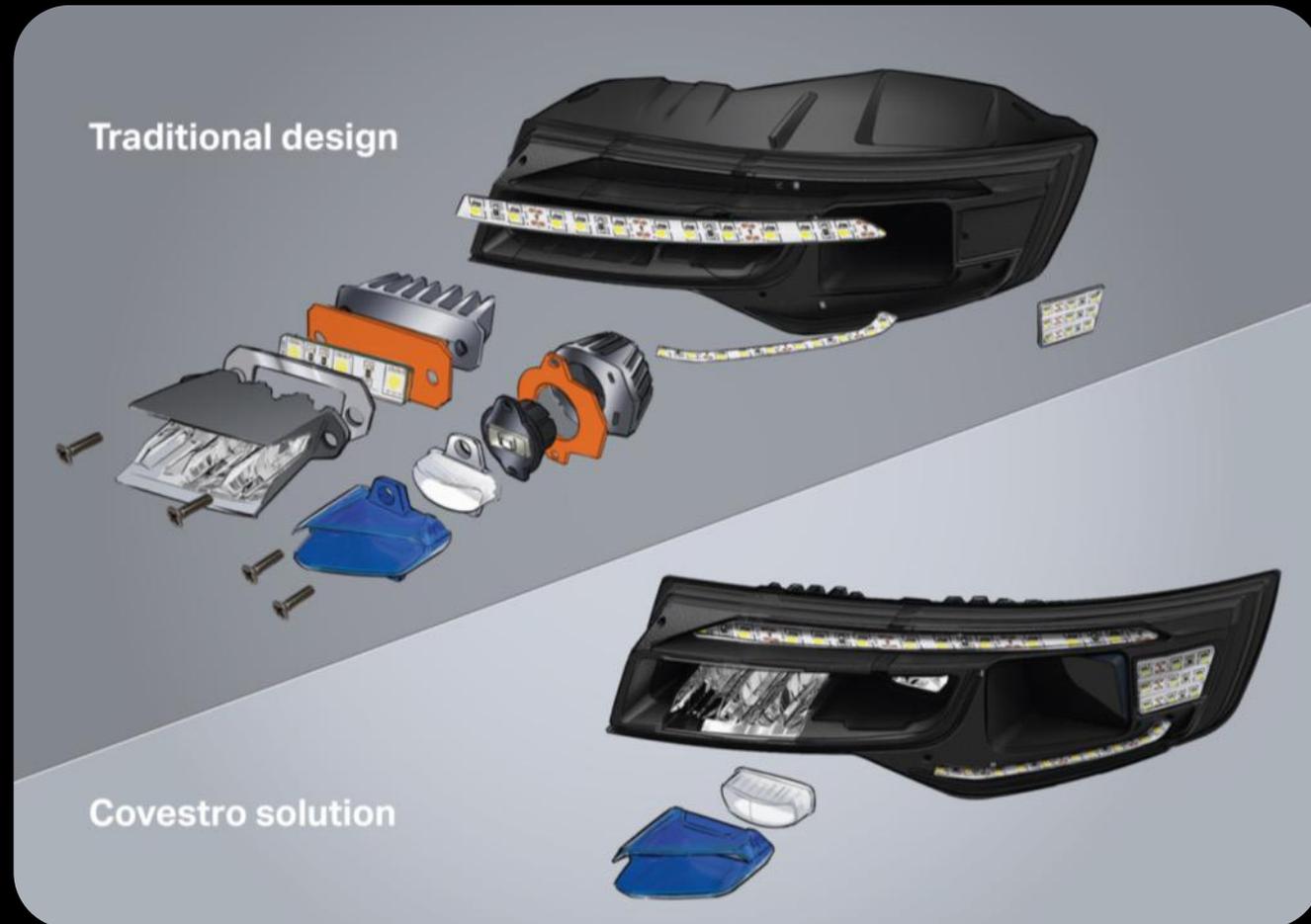


Heat sinks are integral to the housing of thermally conductive Makrolon® TC polycarbonate – moving heat away from the various LEDs and sensor modules.



# Reflectors

Dimensionally stable reflectors are 2K molded into the housing



The high- and low-beam reflectors of Makrolon® DS polycarbonate are **2K multi-shot molded** with the Makrolon® TC housing, **eliminating 60 components**: heat sinks, fasteners, brackets, thermal interface material and adhesive.

Makrolon® DS also exhibits **isotropic, low thermal expansion** for enhanced reflector optics.



# Bezel

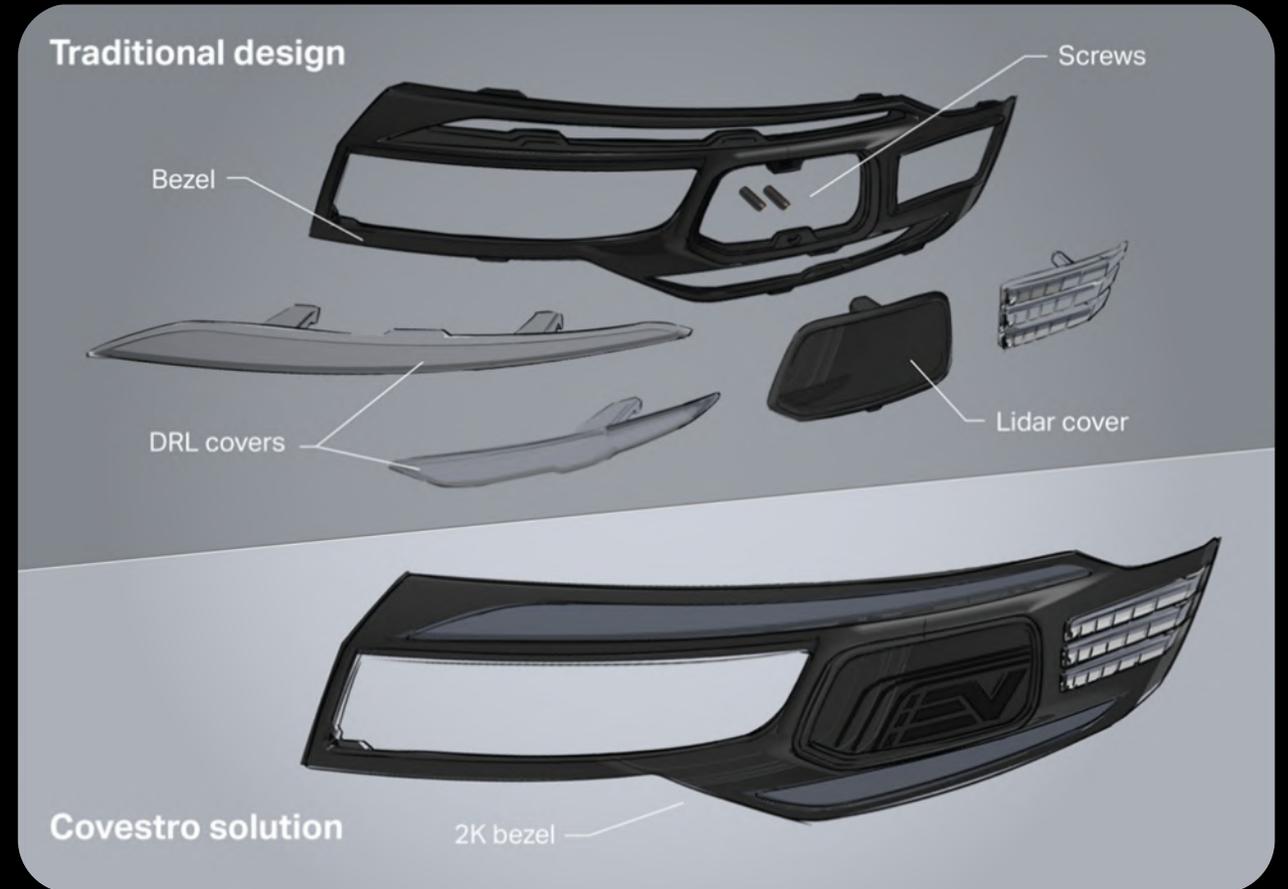
3K molding consolidates multiple features into the bezel



Three separate components are consolidated into one via 3K multi-shot molding:

lidar cover of Makrolon® ST,  
DRLs of Makrolon® DQ, and  
turn signals of Makrolon® LED,

combining IR transparency, diffusion & amber color into one part ... with reduced cost.



# Sustainability



The concept aligns with UN Sustainable Development Goal 12:  
“Ensure sustainable consumption and production patterns.”



## Simplified Material Use



- + Fewer number of dissimilar materials
- + Can be recycled as a sub assembly
- + Smaller parts, easier to handle

Separate recycling streams:  
PC Optical and PC Blend



General recycling stream:  
PC Blend



The mono-material design strategy leads to a LED headlamp system using **only polycarbonate-based materials** and UV/hardcoating (outer lens cover) and metallization (reflector) to enable:

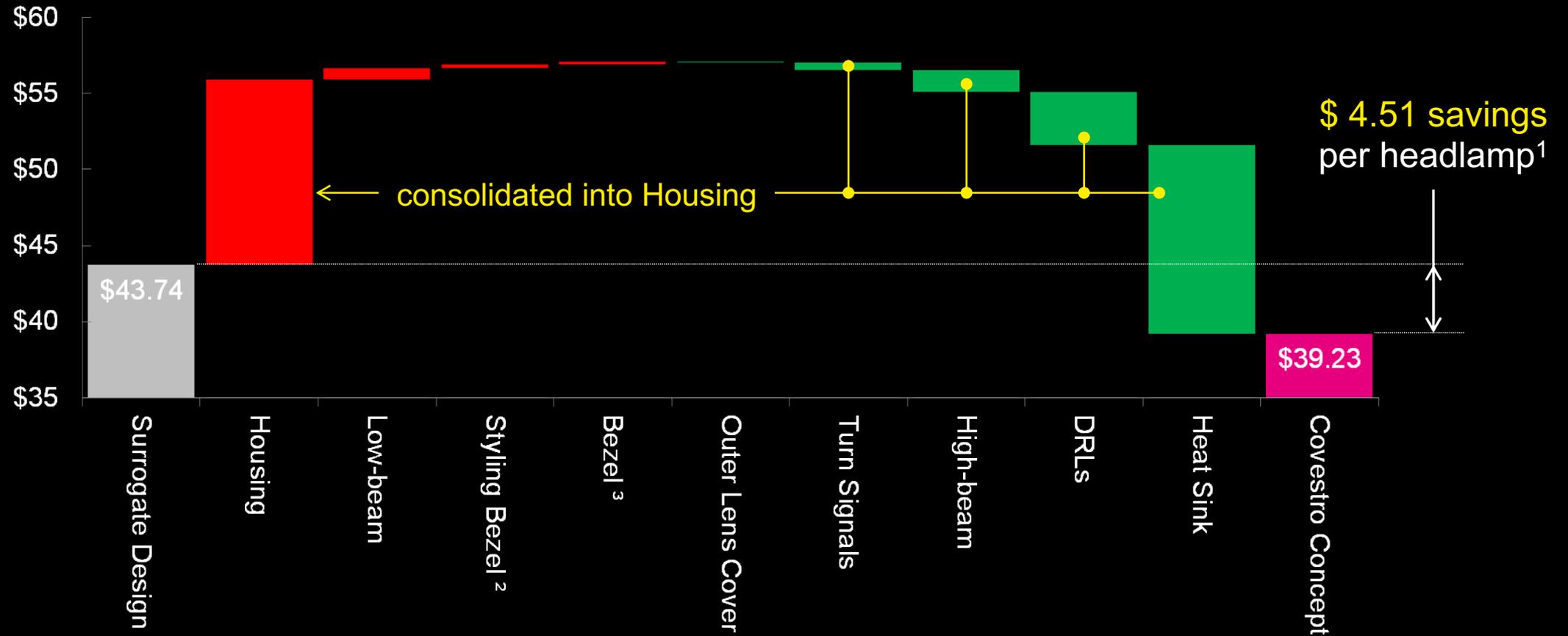
- **easier recycling**
- **less parts, tooling and assembly**
- **sustainable manufacturing**
- **lower energy use**



# Economics



Part consolidation, enabled by the mono-material strategy, can yield significant cost savings.



<sup>1</sup> cost per headlamp, excluding cost of 1) LED and lidar electronics, 2) profit  
<sup>2</sup> dissimilar design concepts ... <sup>3</sup> unique, only in Covestro Concept



# Quick View of Case Study

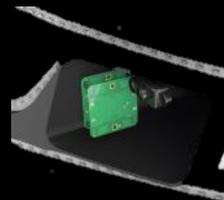
1 Reflective Heat Sink



2 LED Fog Lamp



3 Sensor Transparent Bezel



# Case Study | 1

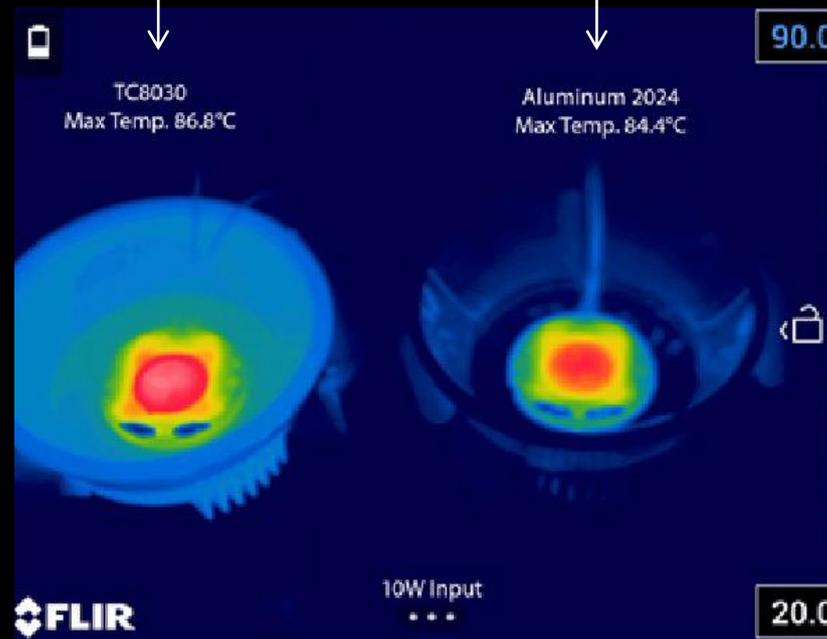
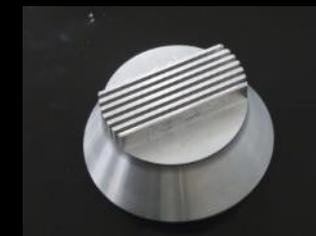
Heat Management: Reflective heatsink for consolidated automotive LED lamps



Makrolon® TC8030  
14 W/m-K



Aluminum  
~130 W/m-K



Only ~2°C difference in temperature at the LEDs, with a 50% weight savings.



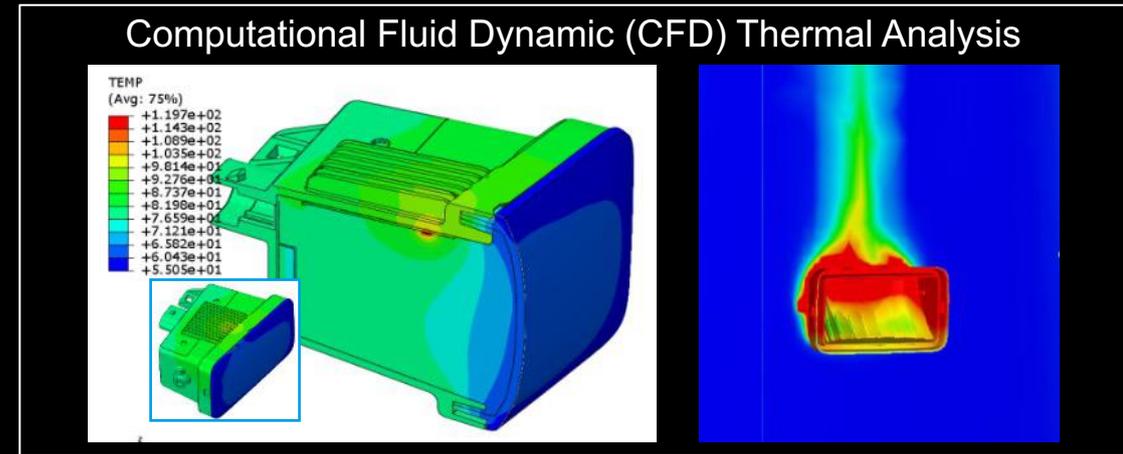
# Case Study | 2

## Heat Management: LED Fog Lamp Housing



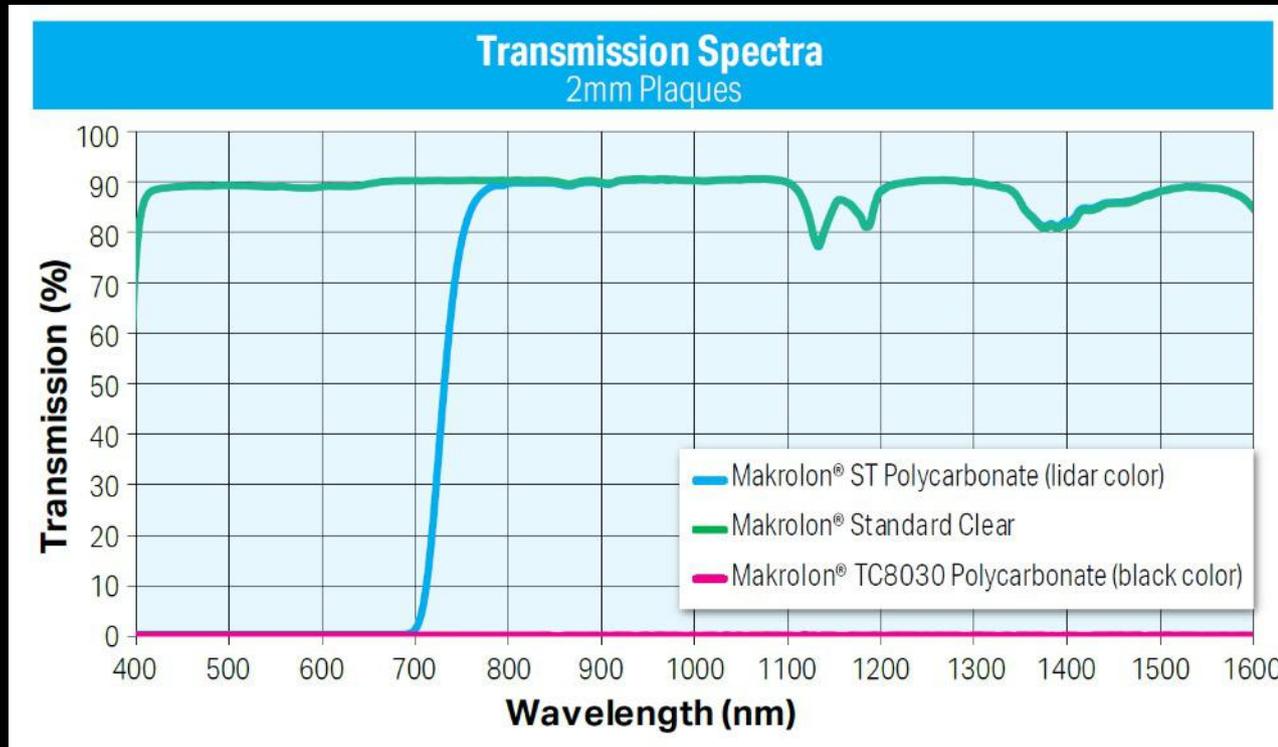
### Makrolon® TC8030 advantages over cast aluminum:

- Good thermal management of 9 W LED
- 46% weight-savings
- 20% cost reduction
- 30 lumen increase
- Vibration durability
- Mono-material solution

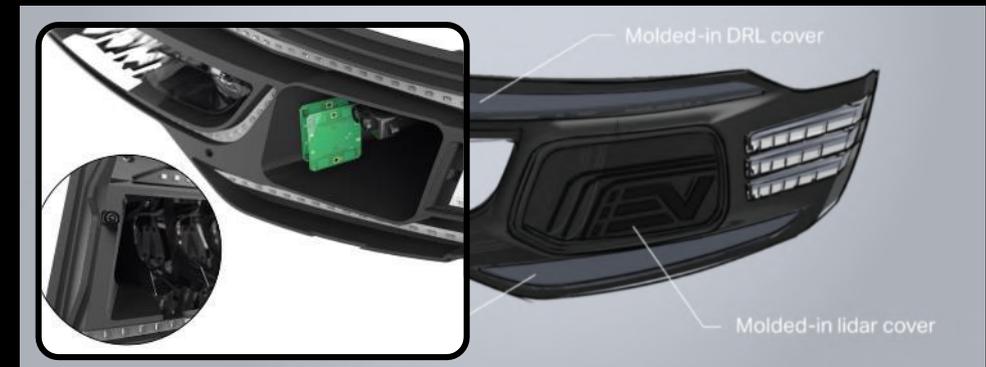


# Case Study | <sup>3</sup>

Sensor Transparent Bezel: nearly transparent to lidar wavelength(s)



The visually dark, yet **sensor transparent** Makrolon® polycarbonate bezel **hides the lidar hardware from view** and is highly transparent at 850 nm, 905 nm and 1550 nm.



## Summary

- **Cost ~ \$ 4.50 savings per headlamp**  
from significant part and assembly reduction
- **Weight ~ 1.8 kg saved per headlamp**  
from elimination of cast aluminum heat sinks
- **Parts – 60 fewer parts per headlamp**  
from elimination of screws, brackets, heat sinks
- **Space ~ 2-3 cm thinner**  
from part consolidation: heat sinks, sensor elements
- **Styling – progressive aesthetics**  
diffusion, texture, signature lighting, black, metallized
- **Sustainability – less is more**  
easier recycling, single material stream, fewer parts  
fewer manufacturing operations, tools & fixtures  
lighter weight aids improved EV range and emissions



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