

# Mono-material Headlamp Concept

September 2021



[covestro.com](https://www.covestro.com)

# Agenda



## Introduction

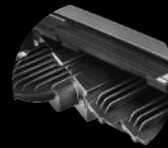
### Covestro

### Headlamp Concept

design overview  
component features  
system economics



## Case Studies



### Performance

Heat management, photometrics, sensor concealment



### Sustainability

Design, products, mechanical recycling, GHG impact



### Questions | Answers

# We push boundaries in key industries of the modern life

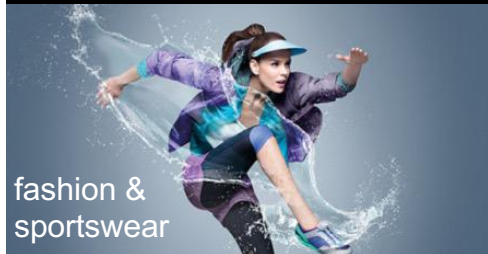
## We are one of the world's leading polymer producers



mobility



construction



fashion &  
sportswear

Over 150 years of innovation history

30 production sites in Europe, Asia, America  
– eight being world-scale plants

2020 sales of €10.7 billion (-13.7% YoYr)

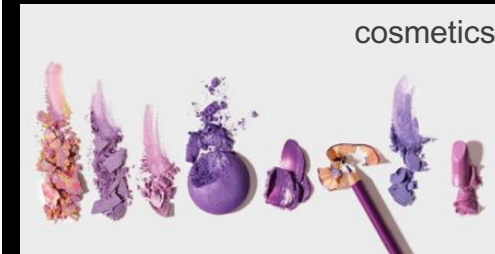
Spinoff from Bayer on September 1, 2015



electronics



health



cosmetics

Shaped by  
our history.

Defined by  
our future.



Bayer MaterialScience is now Covestro.



# Product portfolio

Our three main product groups



## Polycarbonates

Granules for a wide variety of applications

## Coatings, Adhesives

Raw materials for coatings and adhesives

## Polyurethanes

Raw materials for rigid and flexible foams

# Our polycarbonates portfolio

## Our four main polycarbonate product lines



### 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®

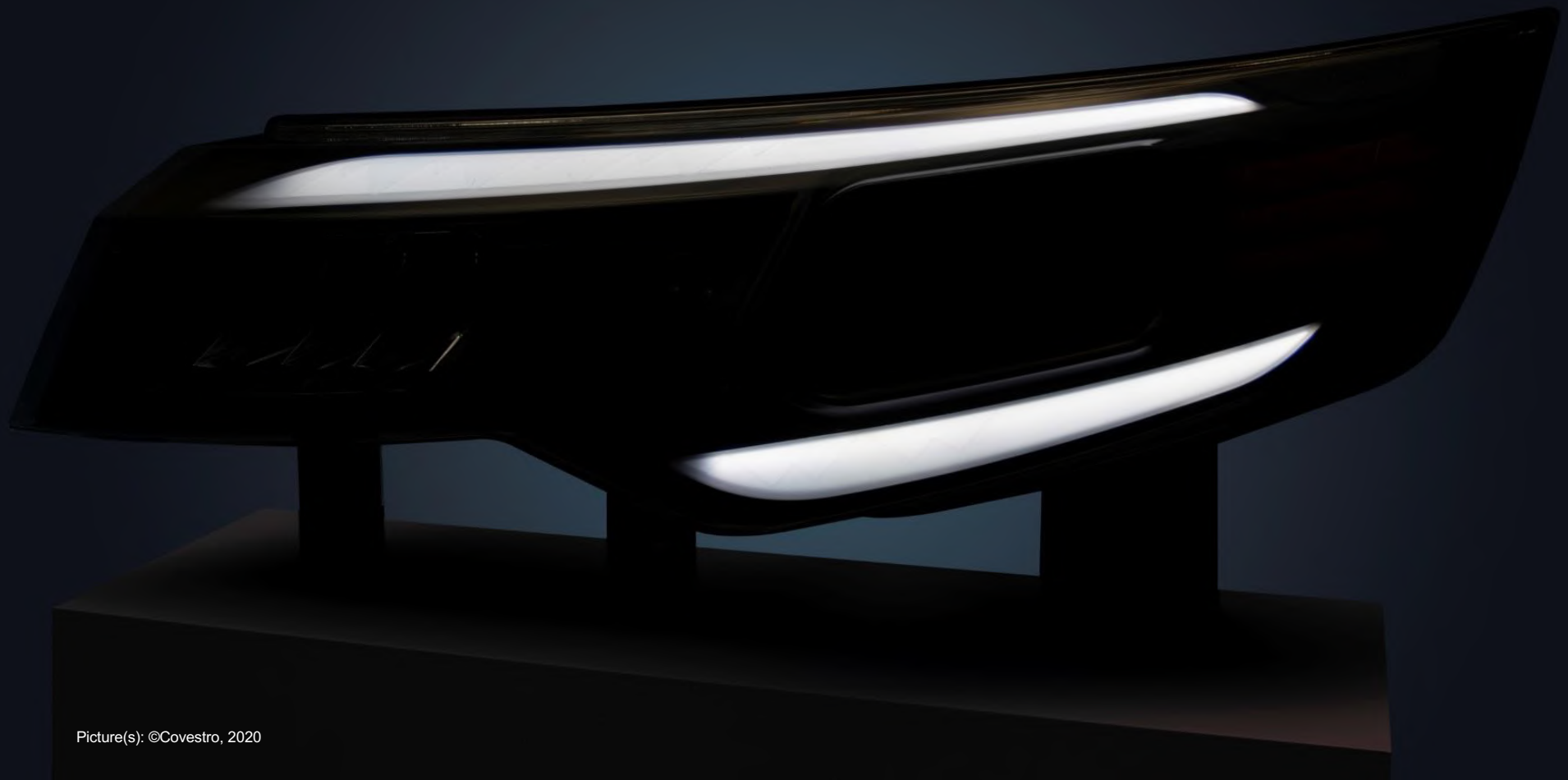
High toughness, chemical  
resistance, low temperature ductility  
(PC+PBT; PC+PET)



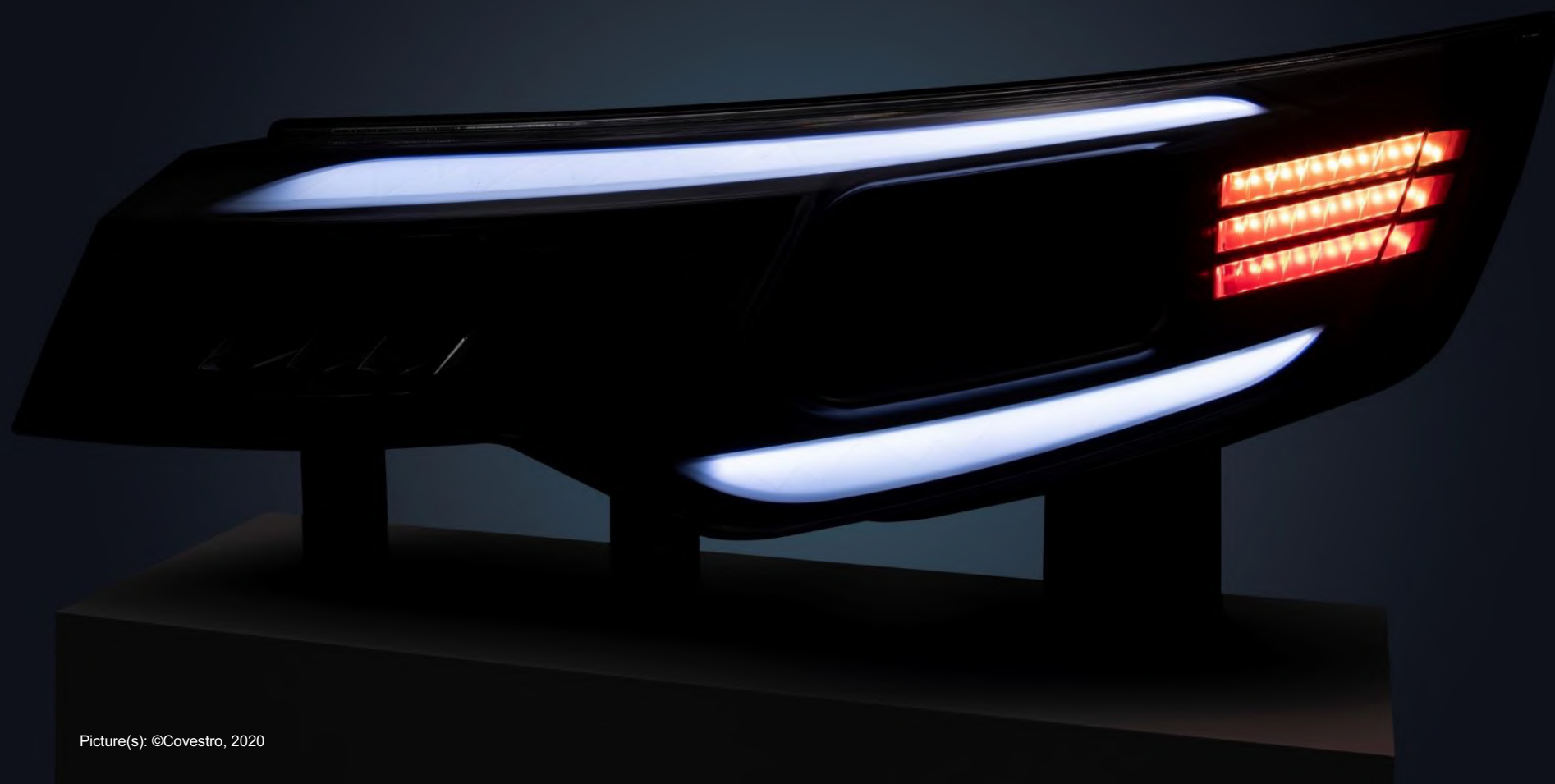




park lights



turn signals





high-beam styling ring / bezel



low-beam



high-beam



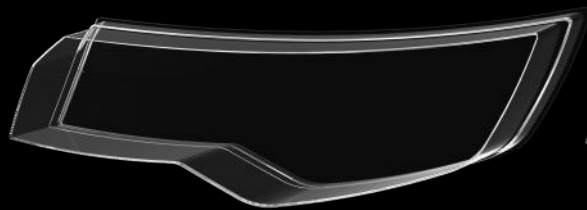






# Mono-material Headlamp System

Novel headlamp system that's exclusively polycarbonate-based



Outer lens cover



3K Bezel

High-beam collimator lens

High-beam styling ring / bezel

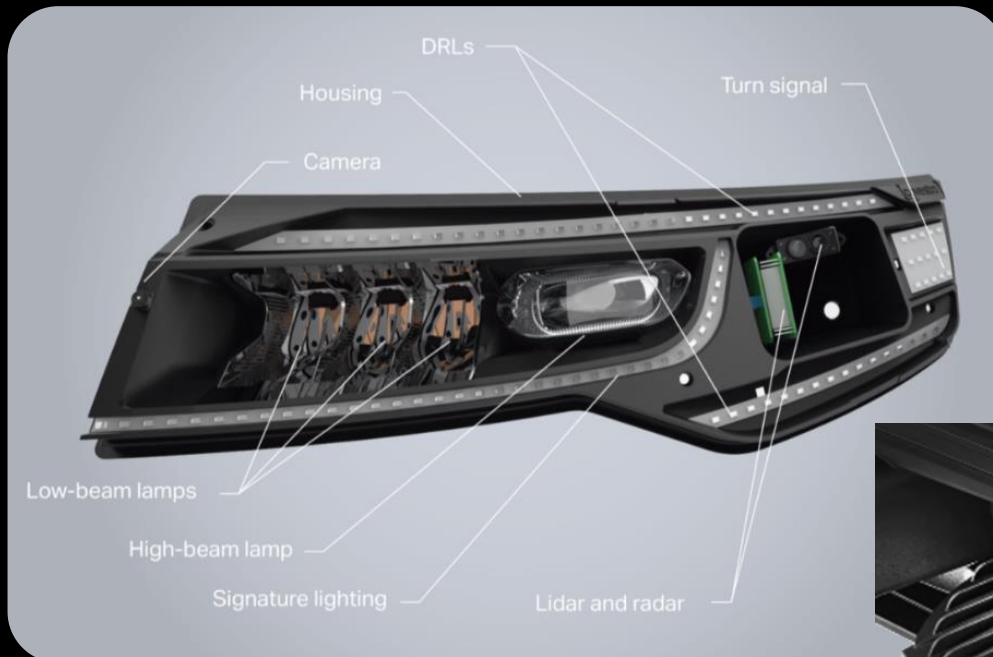


3K Reflector/Housing

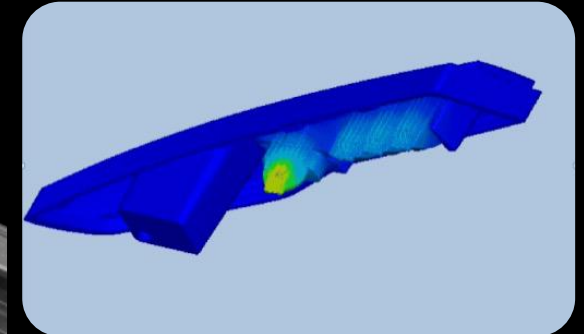


# Housing

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 exhibits **nearly isotropic, low thermal expansion** for enhanced reflector optics.

# Bezel

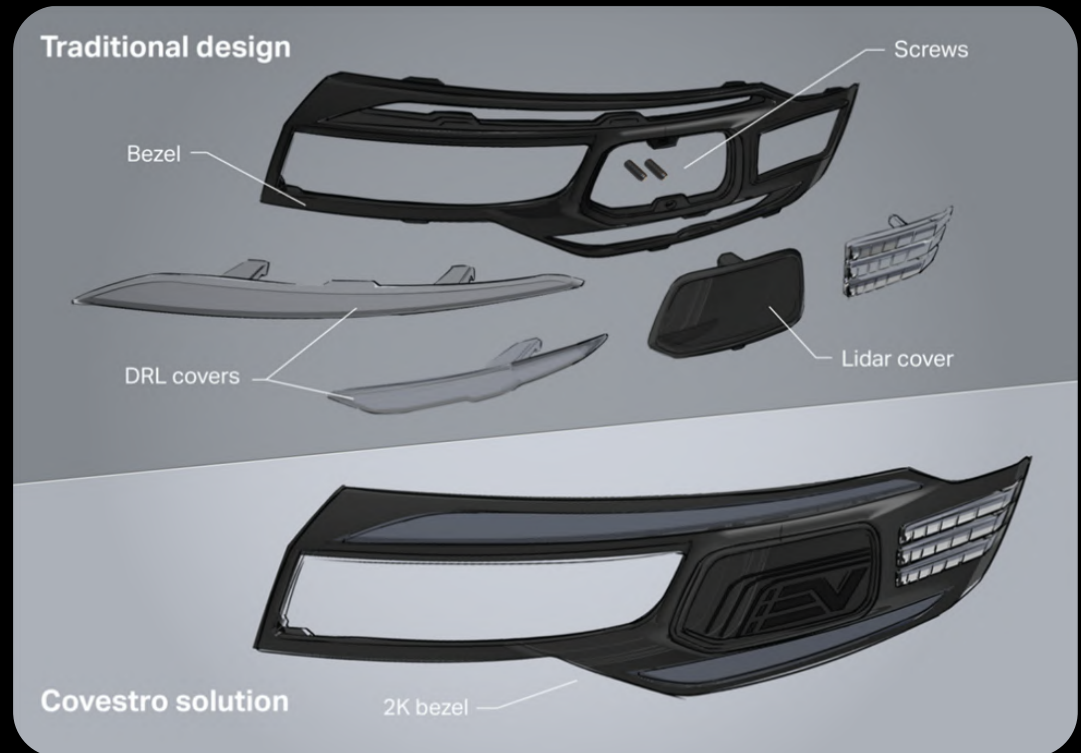
3K molding consolidates multiple features into the bezel



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

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

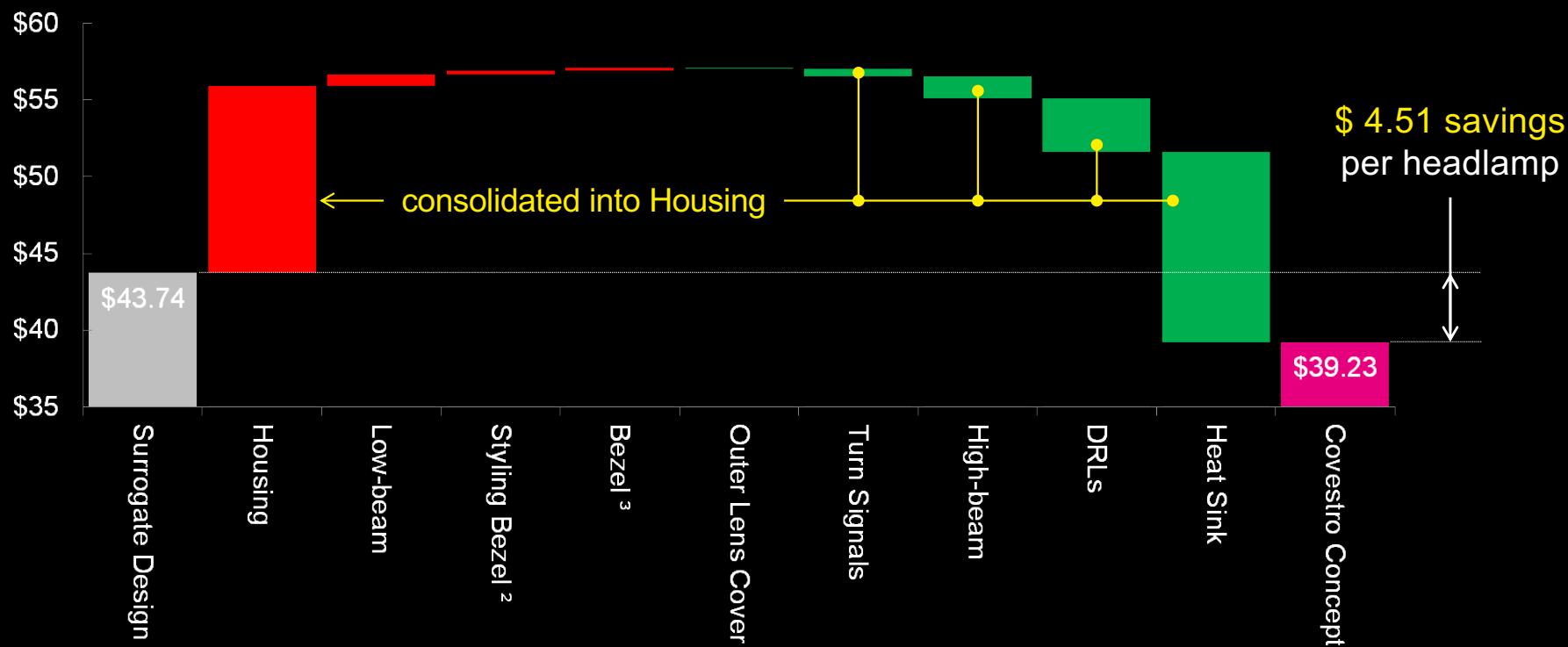
combining IR transparency, diffusion & amber color  
into one part ... with reduced cost.





# Economics

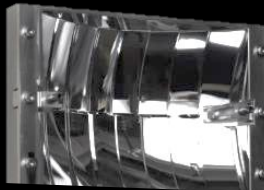
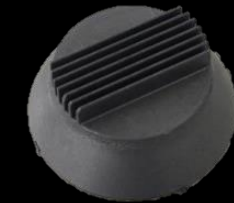
Part consolidation, enabled by the mono-material strategy, can yield significant cost savings.



<sup>1</sup> excluding: 1) impact LED module (\$62.12) & lidar module and 2) profit  
<sup>2</sup> unique, only in Covestro Concept ... <sup>3</sup> dissimilar design concepts

# Performance Case Studies

- 1 Heat management
- 2 Photometrics
- 3 Sensor concealment

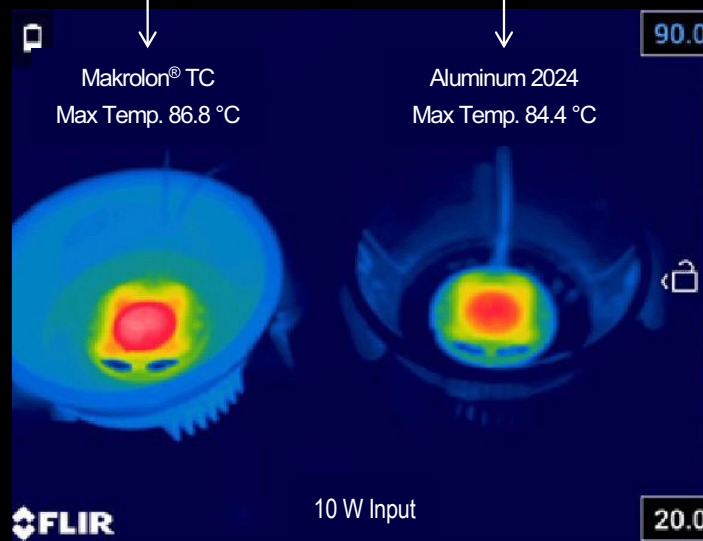


## Case Study | 1a

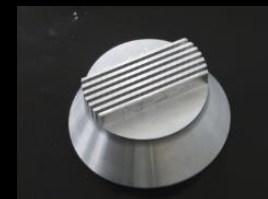
Heat Management: Reflective heatsink for consolidated automotive LED lamps



Makrolon® TC  
14 W/m-K



Aluminum  
~130 W/m-K



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



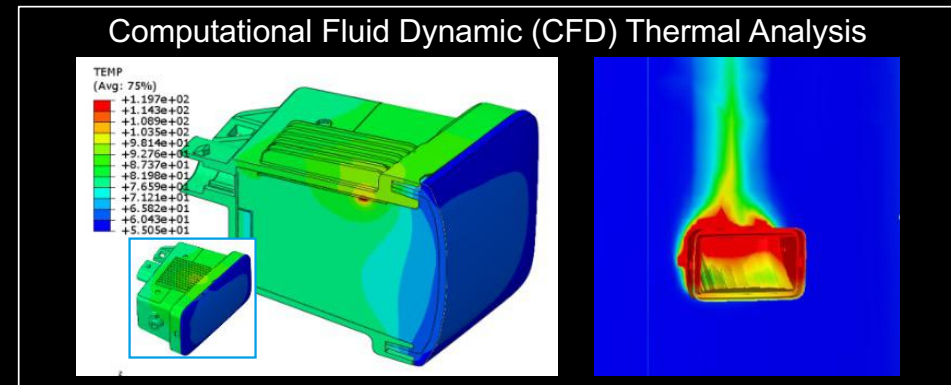
## Case Study | <sup>1b</sup>

### Heat Management: LED Fog Lamp Housing



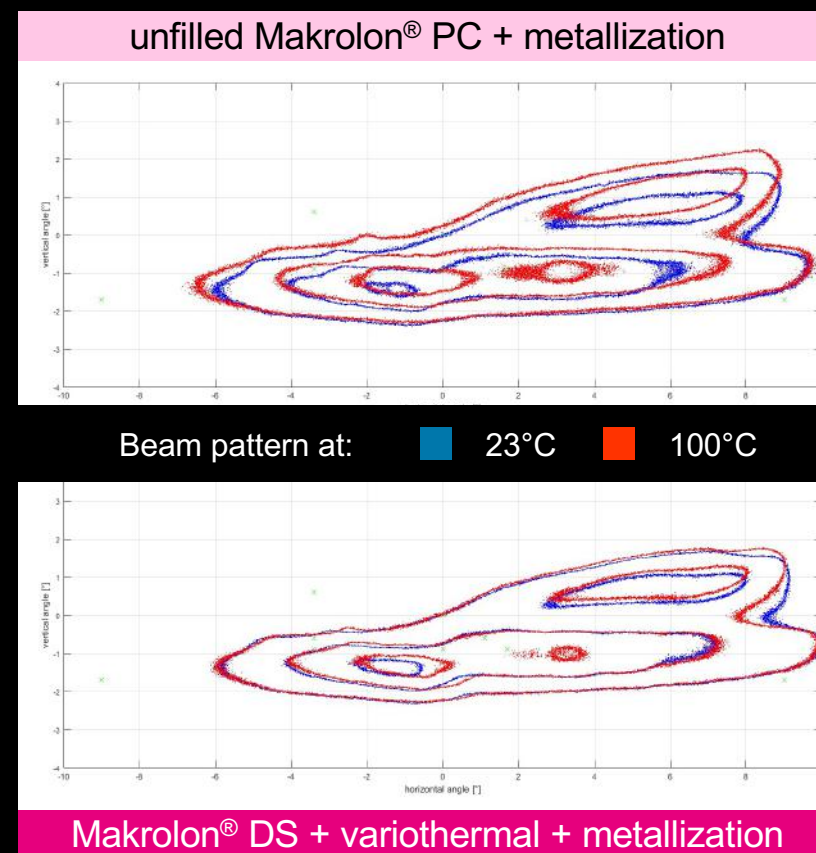
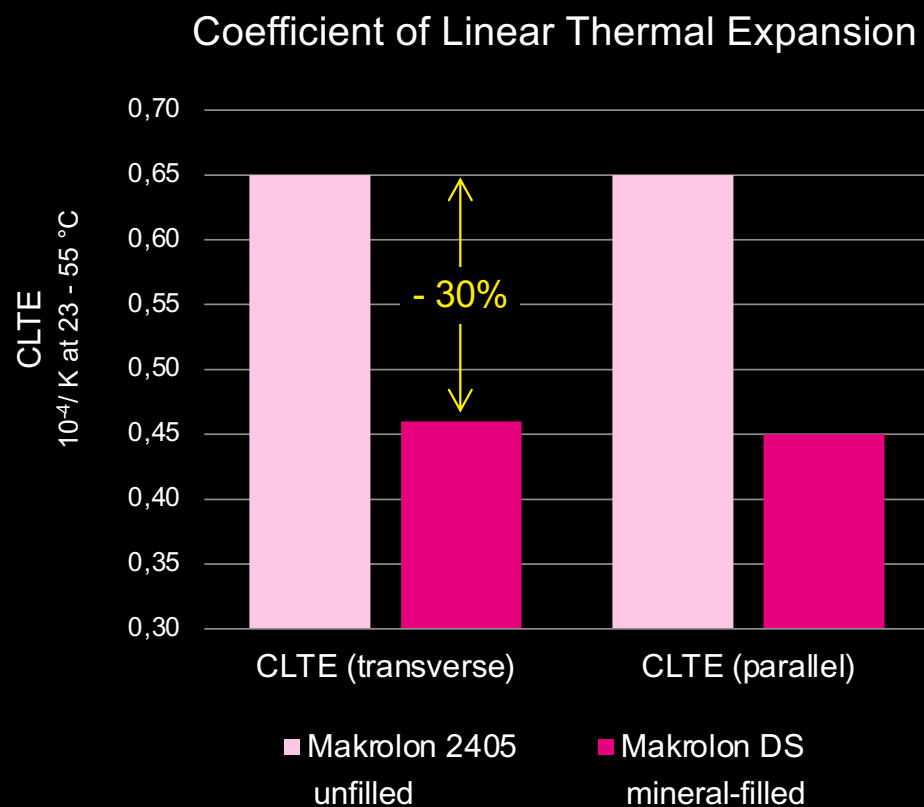
#### Makrolon® TC performance verses cast aluminum:

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



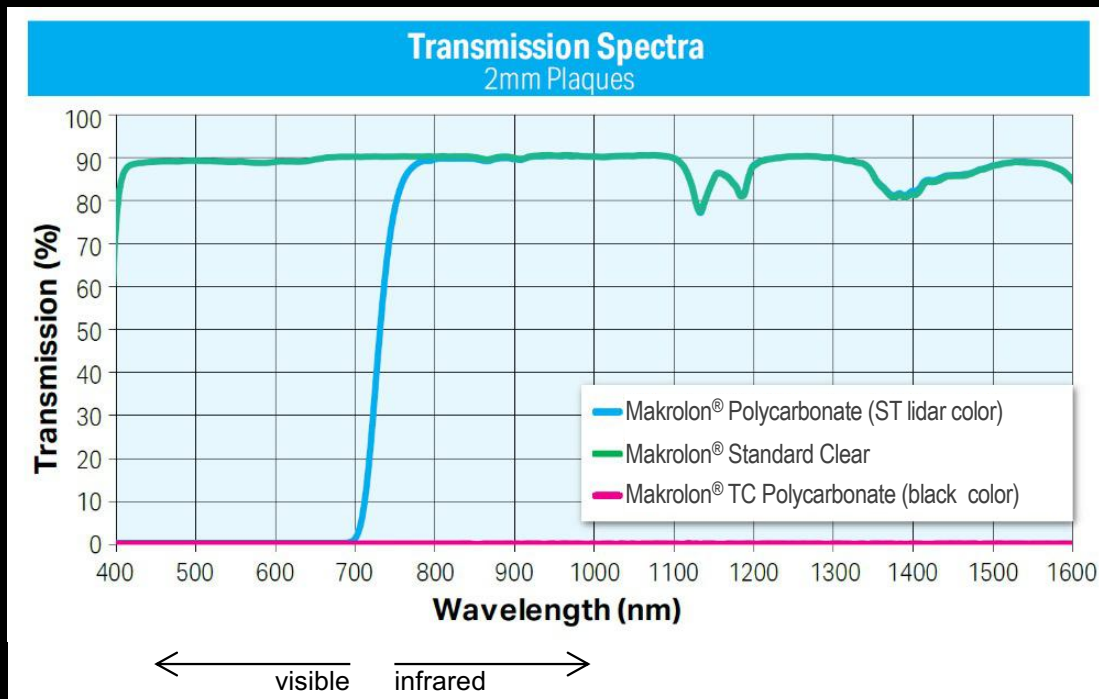
## Case Study | <sup>2</sup>

**Photometrics:** Low, isotropic CLTE of Makrolon® DS for a stable photometric pattern



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

**Sensor Concealment:** Makrolon® ST is 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.



# Sustainability Case Study

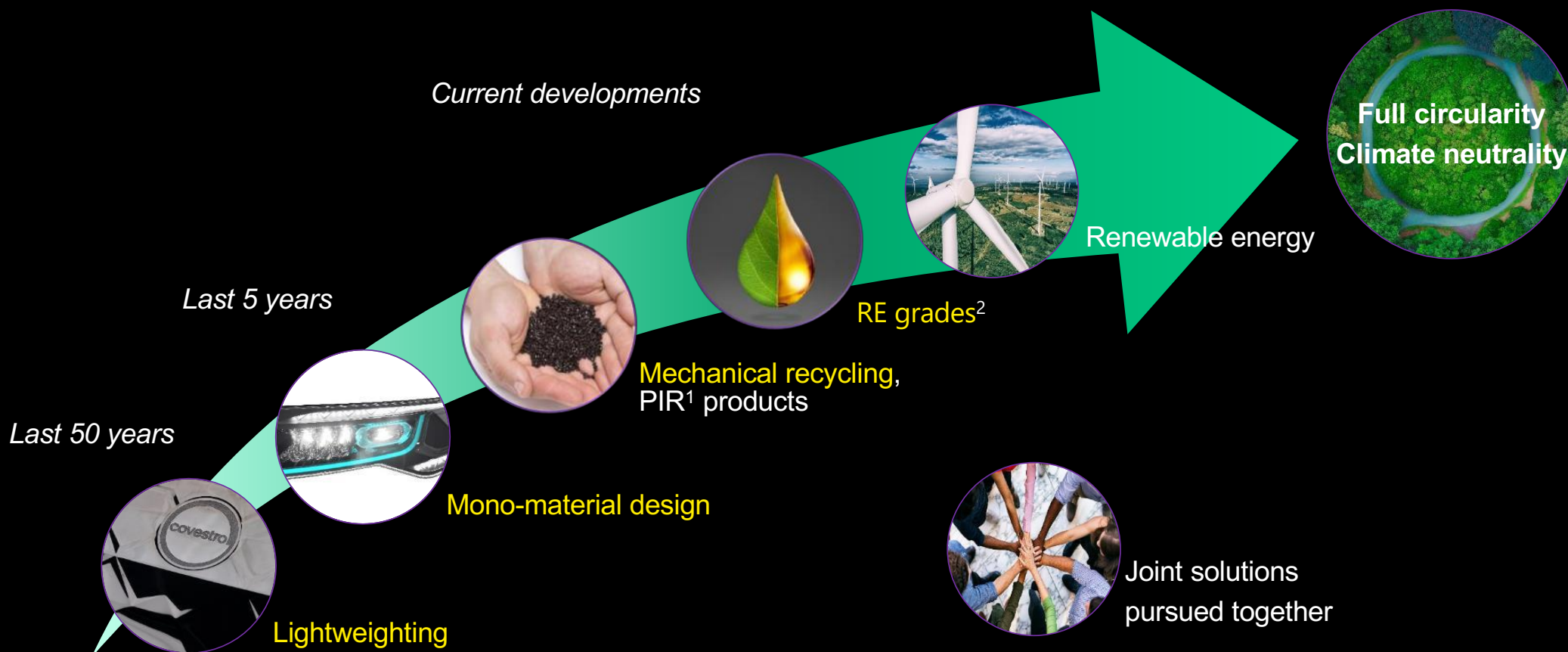
- 4a Design and products
- 4b Mechanical recycling
- 4c Cradle-to-Gate(s) impact





# Our Journey

Multiple steps available on the way to becoming fully circular – together!



## Case Study | 4a



Design and products: Enhanced sustainability through design and materials

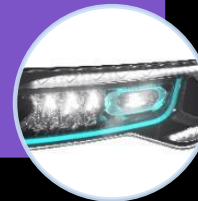
- Lower density materials **save 1.8 kg per headlamp** verses materials used in conventional headlamps
- **Makrolon® TC enables heat sink integration**, eliminating weight attributed to aluminum

Lightweighting



- Streamlined-recycling
- Only **3 material types**<sup>1</sup> used:
  - Polycarbonate-based resins
  - Hardcoat, for outer lens
  - Metalization, for reflectors

Mono-material design



- Renewable attributed products
- 85% of the headlamp's fossil-based resin weight can be replaced with **RE grades**<sup>2</sup> ...  
... **enabling over 70% CO<sub>2</sub>-eq reduction** due solely to this material selection

RE grades<sup>2</sup>



## Case Study | 4b



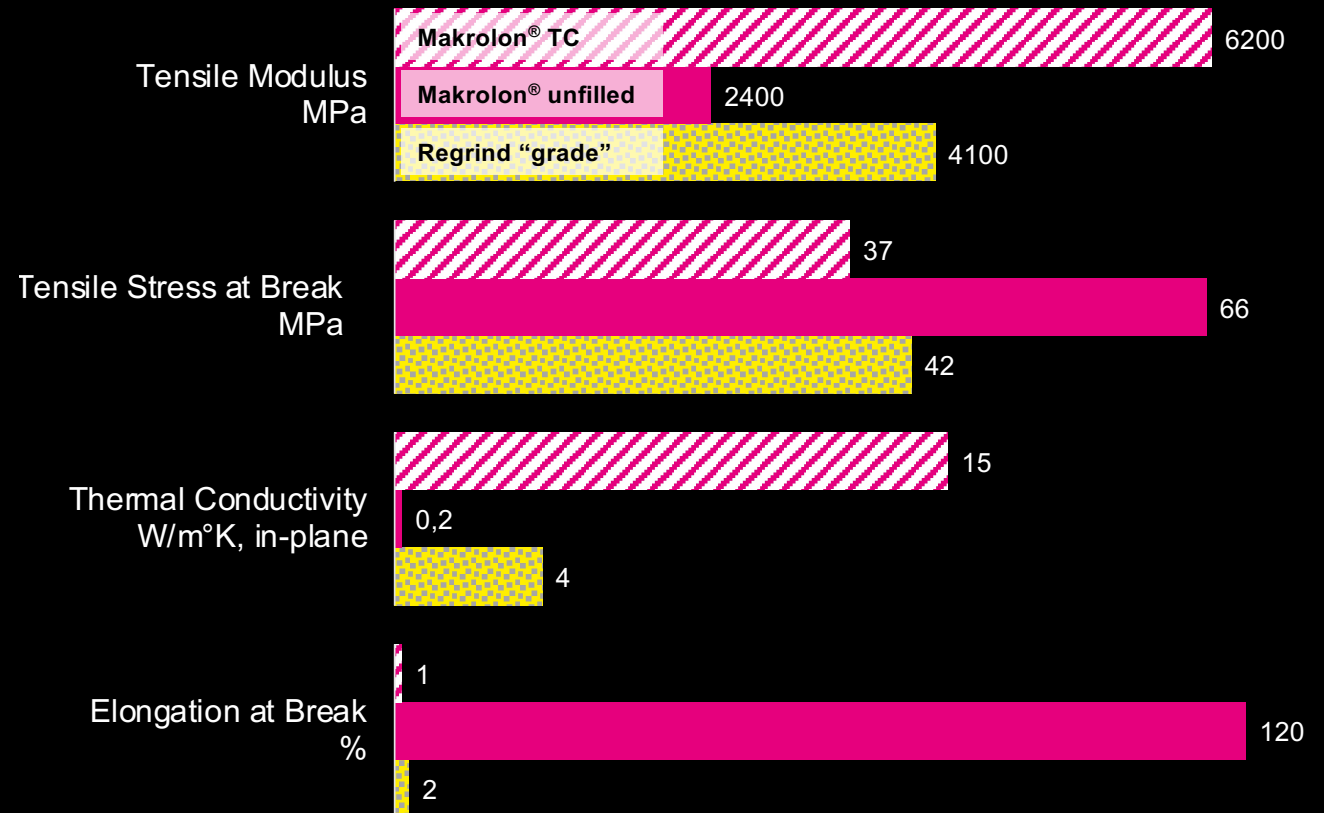
### Mechanical recycling: Property retention after mechanical recycling

- Mechanical recycling the materials of the three main parts<sup>1</sup> of the headlamp concept yields a **new, plausible “grade”** eligible for:

- Housings (opaque)
- Thermal management
- Non-impact, non-aesthetic

- Option to recycle separately:
  - Optical grades
  - Thermally conductive grades

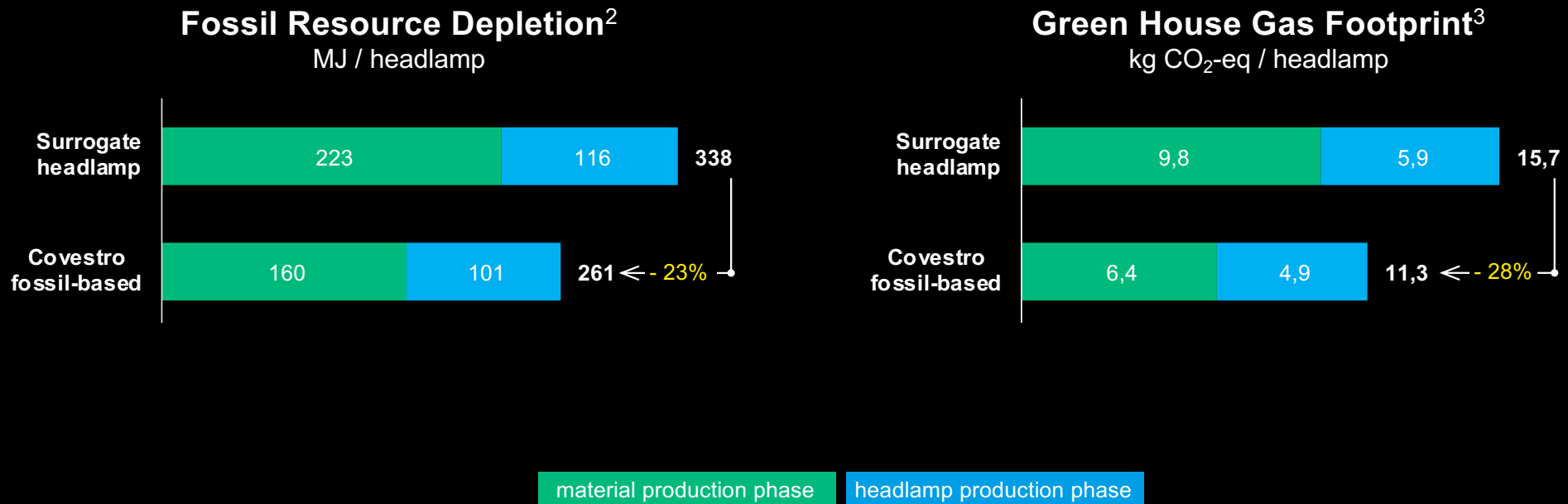
Mechanical recycling



## Case Study | 4c



**Cradle-to-Gate(s) impact:** Reduced use of fossil resources and green house gas footprint<sup>1</sup>



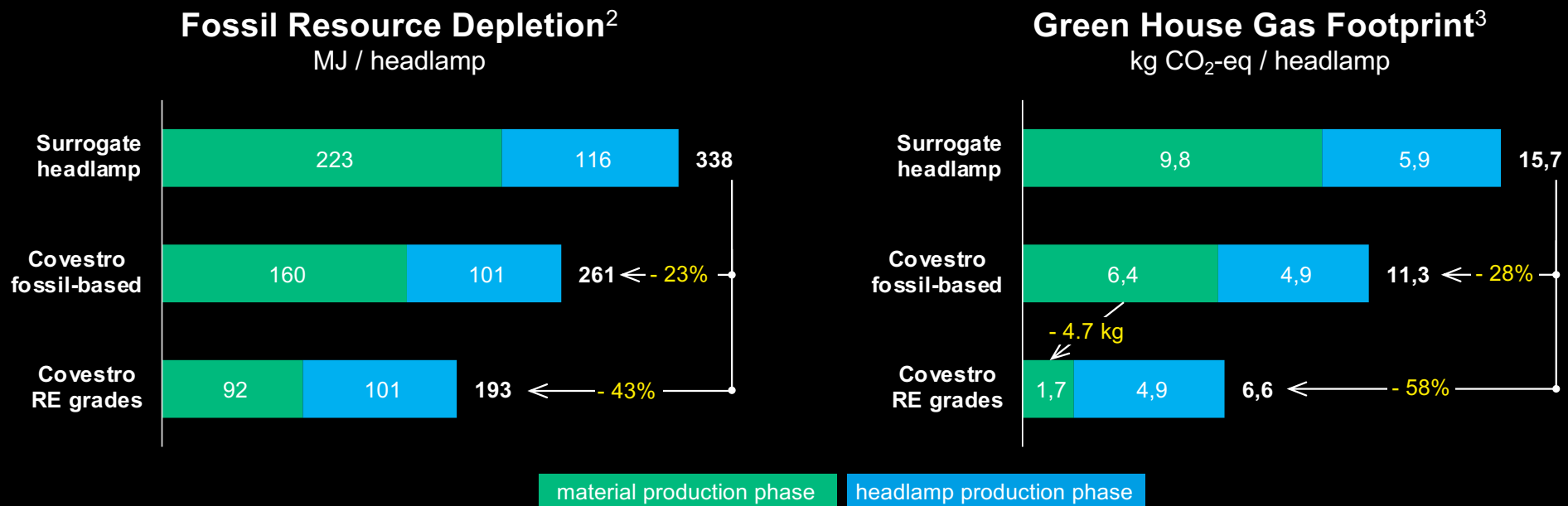
- The Covestro Concept can **save 4.4 kg (28%) CO<sub>2</sub>-eq in the production of a headlamp** with fossil-based materials.



## Case Study | 4c



**Cradle-to-Gate(s) impact:** Reduced use of fossil resources and green house gas footprint<sup>1</sup>



- The Covestro Concept can **save 4.4 kg (28%) CO<sub>2</sub>-eq** in the production of a headlamp with fossil-based materials.
- Using **Makrolon® RE polycarbonate** can save an **additional 4.7 kg CO<sub>2</sub>-eq** ... that's a reduction of **9.1 kg (58%) overall** !



## Summary

Cost	~ \$ 4.50 cost savings	} per headlamp
Weight	~ 1.8 kg less	
Parts	~ 60 fewer	
Energy	~ 23-43% reduction	
GHG	~ 28-58% reduction	

## Performance

Heat management, photometrics, sensor concealment

## Sustainability

Design, products, recycling, cradle-to-gate(s) impact



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## Questions | Answers



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