GORE® AUTOMOTIVE VENTS FOR EXTERIOR LIGHTING

Battery-Electric Vehicle (BEV) Headlamps: Unique Challenges and Proven Solutions

Ronald Szewczyk,
Application Engineer
28th DVN Workshop

Together, improving life

Industry trends: Lighting is key to the driving experience, ADAS performance, and brand differentiation

Visibility systems = Cooperative integration of sensors, cameras, mirrors and lighting

Thinner, less deep/more modular lamps:

- Thinline headlamp lenses as small as 5mm in height

Broader **applications:**

- 360° illumination
- Lighting support for sensors, cameras
- Visibility/safety/driver comfort

Lighting systems can **integrate sensing/communication devices + multiple technologies:**

- Fewer ECUs: zoned or master units instead
- LEDs: Mini, Micro, Matrix, High-Luminance
- OLEDs, Lenticular films, Lasers, Xenon

Differentiation:

- Illuminated brand signatures
- Illuminated panels
- Digital luminosity

Diverse trends, shared need: condensation-free lenses

BEV headlamps are vulnerable to condensation, even though they typically run cooler than ICE headlamps.

New technologies: New causes for an old problem

BEV headlamp condensation can actually be worse than with ICE vehicles

What's different about BEV headlamp condensation?

- Moisture moves and accumulates differently in BEV headlamps.
- Issues that cause condensation are also different.

Our extensive on-car and climate-chamber testing helped us understand and quantify the differences:

- This presentation will give you an overview of the unique issues.
- **See us in booth S5** to learn more, review our data, and discuss what that could mean for your next BEV lighting project.

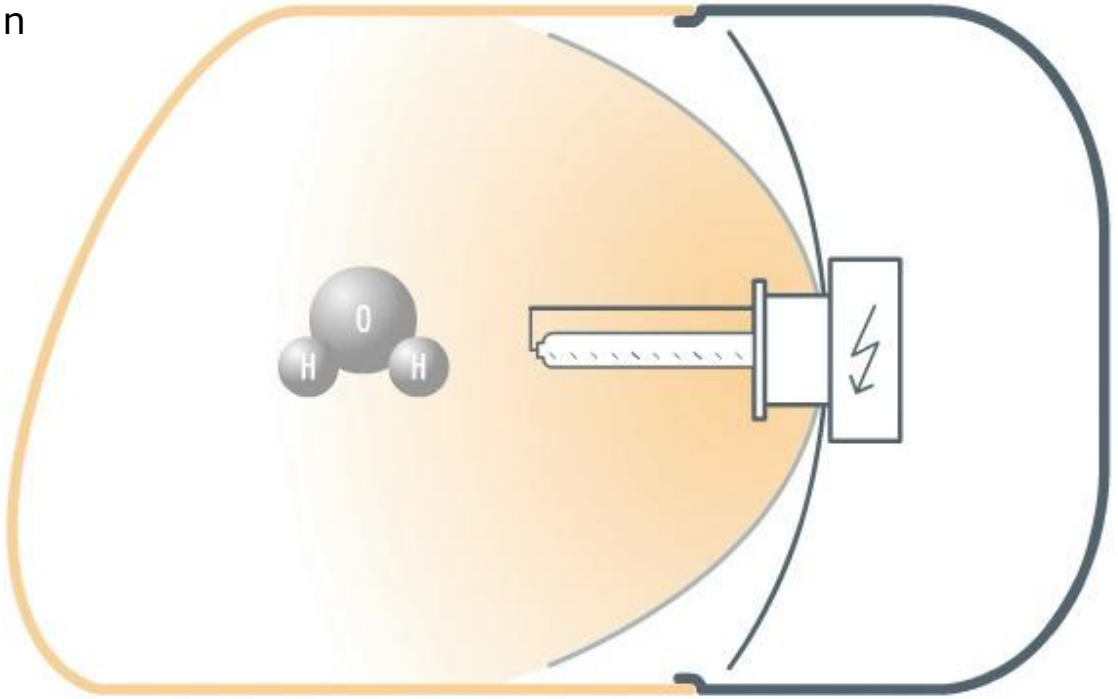
Primary sources of moisture (for both ICE and BEVs)

Moisture transfer via plastic

Two transfer mechanisms

Sorption within and on plastic surfaces

Permeation through the plastic



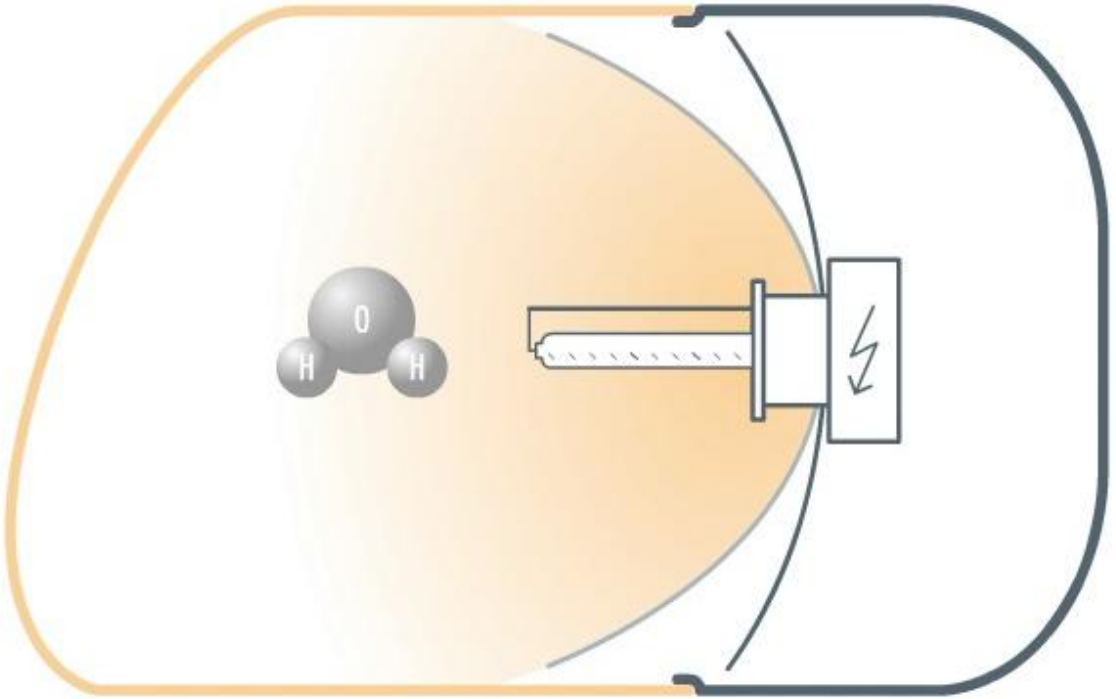
What's unique to BEVs?

Lack of front engine / radiator heating.

- Frequent BEV drive-cycles at lower temps encourage moisture to accumulate.
- Prolonged condensation clearing times.

The problem begins, and builds up

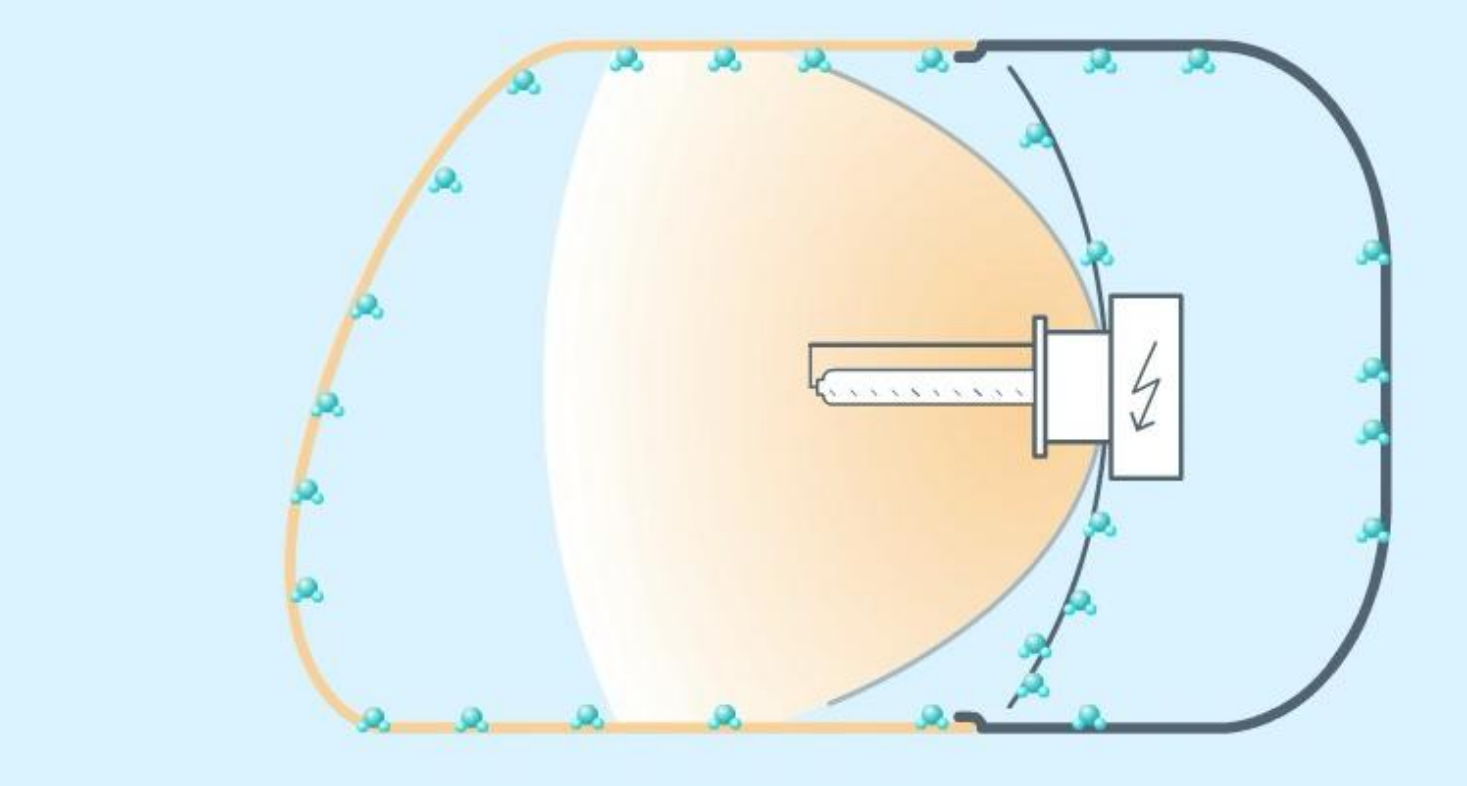
Driving: lamp temp follows ambient temp



- Low-temperature BEV driving cycles encourage moisture collection on / within plastics.
- Repeated driving cycles = More held moisture; greater condensation potential.

The trigger event

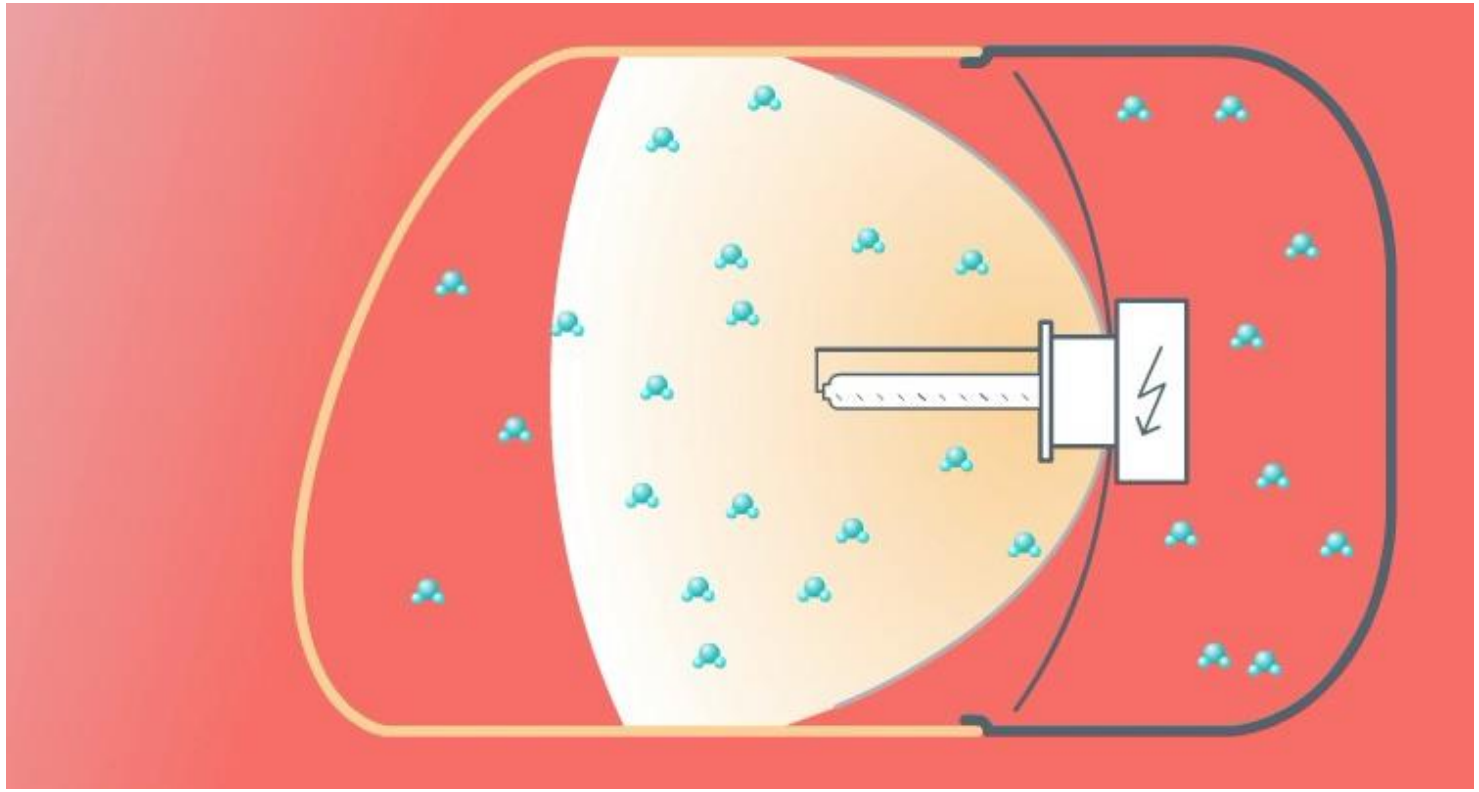
Exposure to external heat source



- External heat (sun load, fast-charging) releases moisture into enclosure.

The consequence

Exposure to external cooling



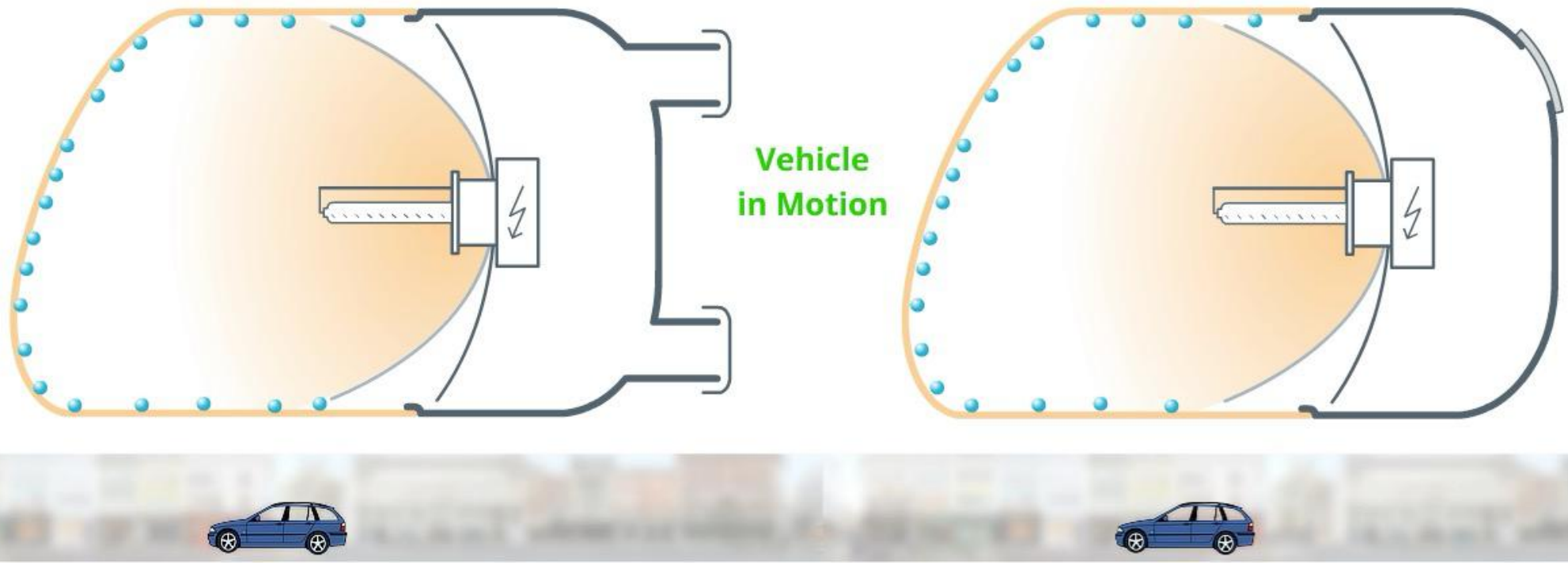
- External cooling (wind, rain, nightfall) converts internal moisture to lens condensation.

Once you have condensation, you need effective clearing

Two methods to clear condensation from an enclosure

Convection: works only when the vehicle is moving

Diffusion: works whether vehicle is on or off, moving or still



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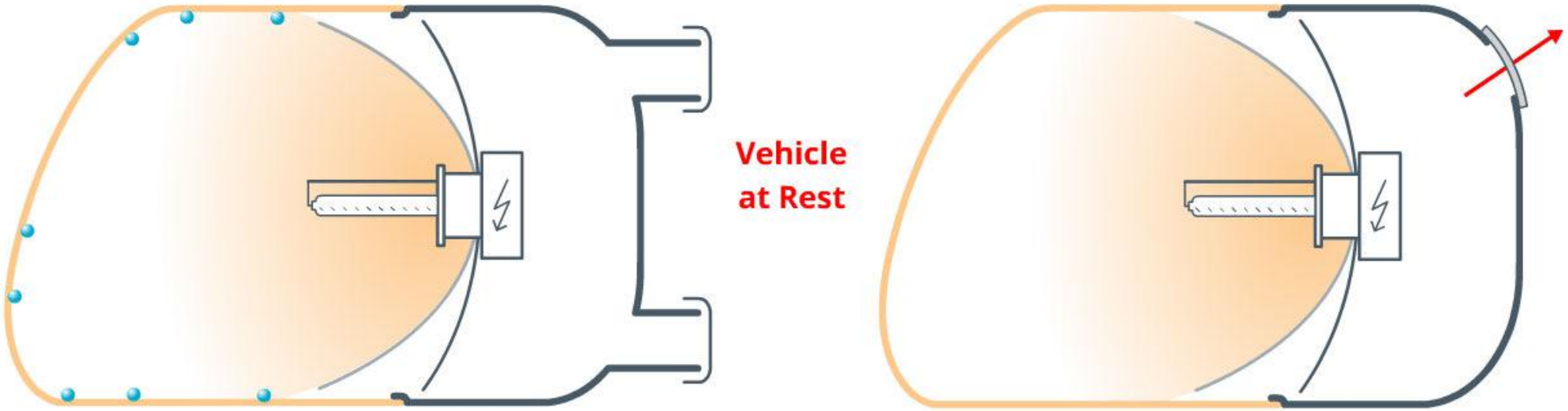
Diffusion



GORE® Vents use diffusion, the best way to clear condensation.

Our on-car data quantifies this process. Come see us at booth S5 for a deeper dive into the data.

Why does better clearing matter?

Industry focus on autonomous driving and sensor integration

- What are the impacts of condensation on clear view and sensor autonomy?
- Need for best-in-class (diffusive) venting to mitigate condensation?
- What is the value of quality vs. risk of warranty costs and brand reputation?

Why choose Gore to help you light the future?

We offer more ways to deliver value, through innovation-focused product leadership and support

Proven product performance

- Automotive portfolio depth/breadth: lighting, electronics, powertrains, batteries
- Product functionality & consistent quality
- Material characteristics (customizable)

Innovation capabilities

- Innovation center
- Membrane-eering
- New product development pipeline
- Reduced carbon footprint

Service & support for your operations

- Application expertise (3+ decades)
- Industry certifications (internationally)
- Regulatory compliance (e.g., REACH)
- Tech service/global availability
- Testing capabilities & processes
- Production capacity / scale
- Global supply chain stability

THANK YOU!

Any questions about BEV headlamp condensation you'd like to discuss?

See us at **Booth S5** to learn more!

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W. L. Gore & Associates, Inc.
401 Airport Rd. Elkton, MD 21921
T +1 800 523 4673 **F** +1 410 5068749
gore.com/autovents