Makrofol® meets Canatu CNT

State-of-the-art transparent heater for LiDAR.

Advancing autonomous driving in any weather.

CANATU

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Makrofol® meets Canatu CNT technology

Improving LiDAR reliability

Reliable LiDAR (Light Detection and Ranging) systems are critical in the development of autonomous driving. One key challenge in automotive LiDAR adoption is to secure clear visibility in harsh weather conditions. Keeping LiDAR sensor covers free of fog, snow and ice is essential to ensure accurate 3D mapping of the objects. Therefore, Canatu and Covestro have created a state-of-the-art transparent film heater for LiDAR.

High-performance heater for LiDAR

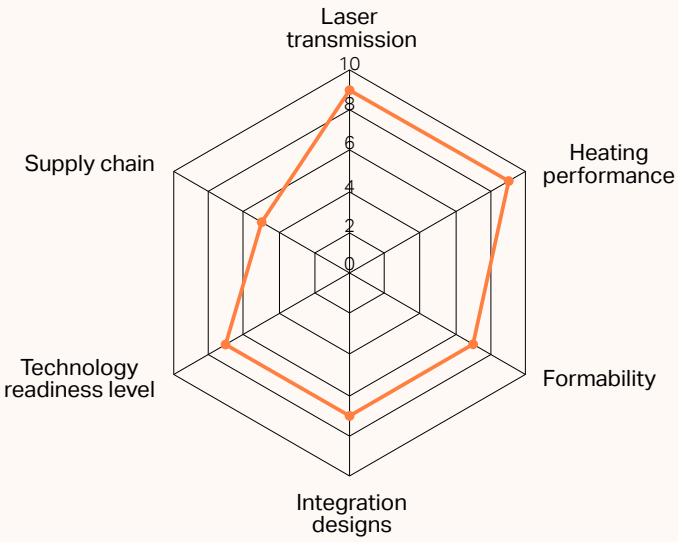
The cutting-edge transparent heater was jointly developed featuring **Canatu CNT technology** on Covestro **Makrofol®** polycarbonate (PC) film. The 3D-formed heater foil is integrated via film insert molding (FIM) using **Makrolon® AG** or **Makrolon® AX PC** resin into the LiDAR front module part. This wire-free thin film heater provides an undistorted field of view (FOV) for the laser beam to create an accurate mapping of the surroundings, advancing autonomous driving in any weather.

High transmittance for sensor resolution

Canatu transparent heaters exhibit very high transmittance for near infrared wavelengths. They can be tailored to customer needs but are typically fabricated at sheet resistance values of 70–200 Ω/□, equaling 96–99% T at 905 nm, and 97–99% T at 1550 nm (without polycarbonate base film).

Benefits at a glance

- High transmittance at LiDAR wavelengths
- Wire-free at the field of view (FOV) without optics degrading temperature gradient
- Fast, even, and power-efficient heating across the whole surface
- Implemented on flexible polycarbonate film substrates, formed into any 3D shape, and processed via FIM to become part of the LiDAR front module
- Proven automotive-grade reliability



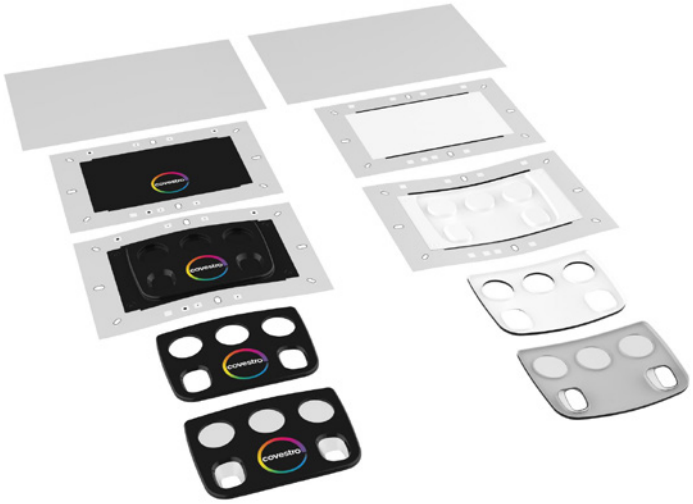
The Canatu CNT-enabled LiDAR heater received high scores on all critical parameters in Covestro's benchmark test comparing transparent heater technologies.

The combination of excellent spectral transmission, heating performance and processing ability stands out. This makes Canatu CNT a promising candidate for the "production-ready" integration of LiDAR sensors into front modules.

Film insert molding (FIM)

During film insert molding, a plastic film is shaped via high-pressure forming (HPF) or thermoforming (TF), trimmed, and the resulting pre-formed insert is placed in an injection mold, where it is back-injected with a thermoplastic.

The FIM process eliminates separate steps, such as coating or painting, that otherwise are required to subsequently decorate or functionalize components. This results in considerable savings in terms of manufacturing costs, time and machine investments. It also creates more flexibility in the production of complex functional parts and results in better reliability.



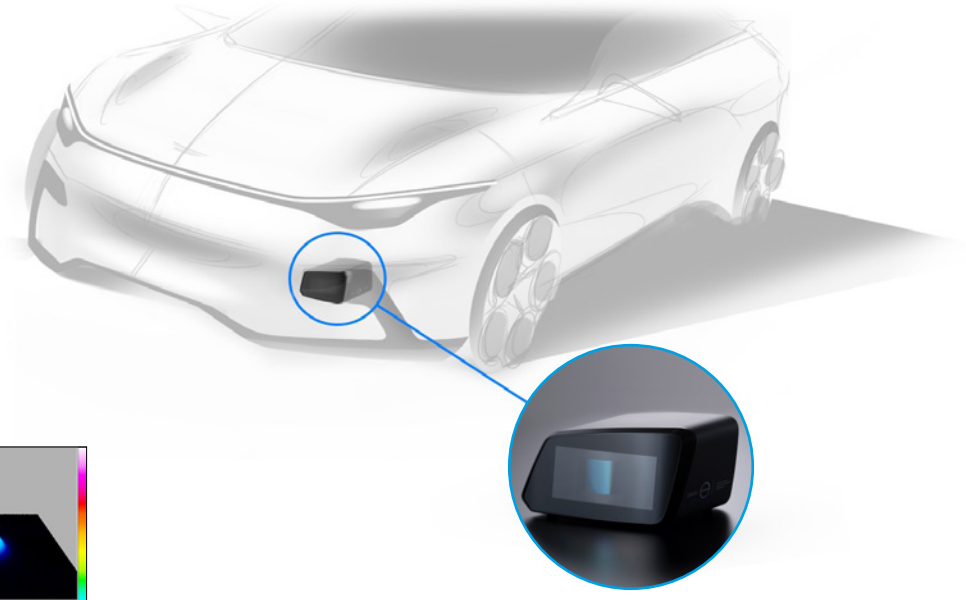
© Covestro
Example of a typical FIM processing chain from a flat piece to an injection-molded functional plastic part

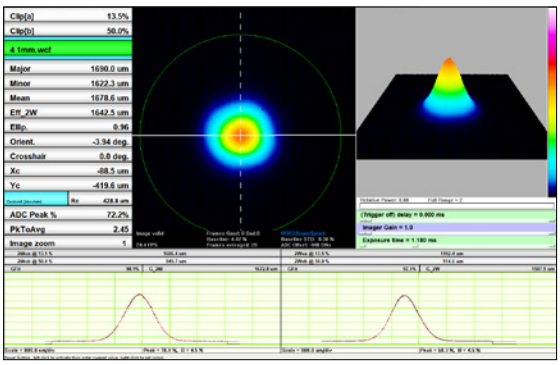
Solution overview

Canatu CNT heaters based on Makrofol® PC film and molded with Makrolon® AG or Makrolon® AX resin can be **flexibly tailored to meet customer heating, optical, and design requirements across a range of input voltages**. The performance in the final molded part can be further supported by applying functional coatings on the back and front surfaces. With the joint demonstrator, Canatu and Covestro are showcasing a solution for LiDAR integration that is highly performant, versatile, and ready for scale-up.

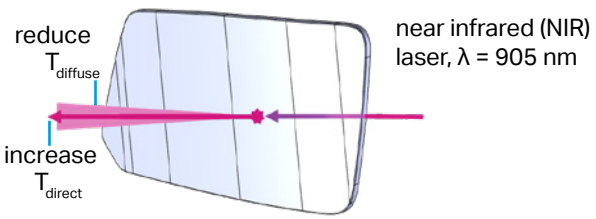
Desired LiDAR properties:

- Symmetric beam profile
- High signal intensity
- Clear sensor image
- No beam divergence



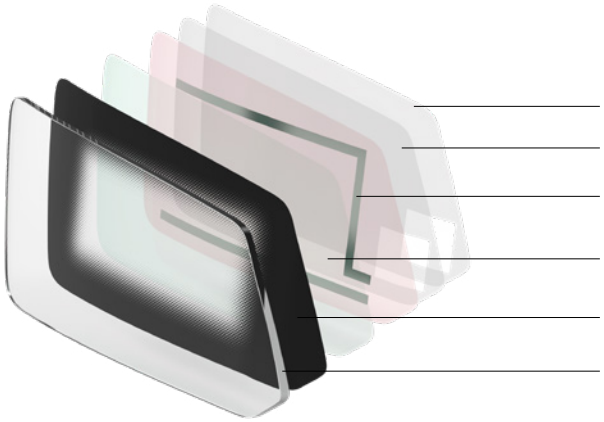


© Covestro
DataRay camera beam profiling software for shape measurement



Canatu – Covestro demonstrator

The new demonstrator features the **Canatu CNT film heater** on Covestro **Makrofol® DE or Makrofol® ST polycarbonate film**, integrated by means of film insert molding (FIM) technology using **Makrolon® AG** or **Makrolon® AX PC resin** on the backside of the film. The demonstrator has an additional protection layer (HTR-N) to protect the LiDAR heater during the FIM process. Please contact your regional sales representative for further inquiries. **Let us create the future of mobility together, today.**



LiDAR cover lens – stack design

Protection layer, printed

Overcoat

Bus bars (silver, printed onto the Canatu CNT layer)

Canatu CNT conductive layer,
printed on Makrofol® DE (clear) or ST (tinted)

Front side fadeout print on Makrofol® DE or ST

Main body of lens, molded with Makrolon® AG2677 (clear)
or Makrolon® AG2675 ST (tinted)

Parameters	General setup	Demonstrator setup
Film type	Polycarbonate	Makrofol® DE polycarbonate
Film thickness	125–375 µm	375 µm
Operating voltage range	12–48 V	12–24 V
Sheet resistance	70–200 Ω/□	100 Ω/□
CNT transmittance (905 nm, without substrate)	96–99%	96.4%
CNT transmittance (1550 nm, without substrate)	97–99%	NA
Total stack transmittance (905 nm, after molding, no coatings)	85.6–88.6%	86%
Total stack transmittance (905 nm, with hard coating and anti-reflective coating)	92%	NA
Haze (with substrate)	< 1%	< 1%
Heater dimensions	600×600 mm	131×67 mm

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