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# Materials for Automotive Sensing

Agenda

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01 **MOCOM Company presentation**

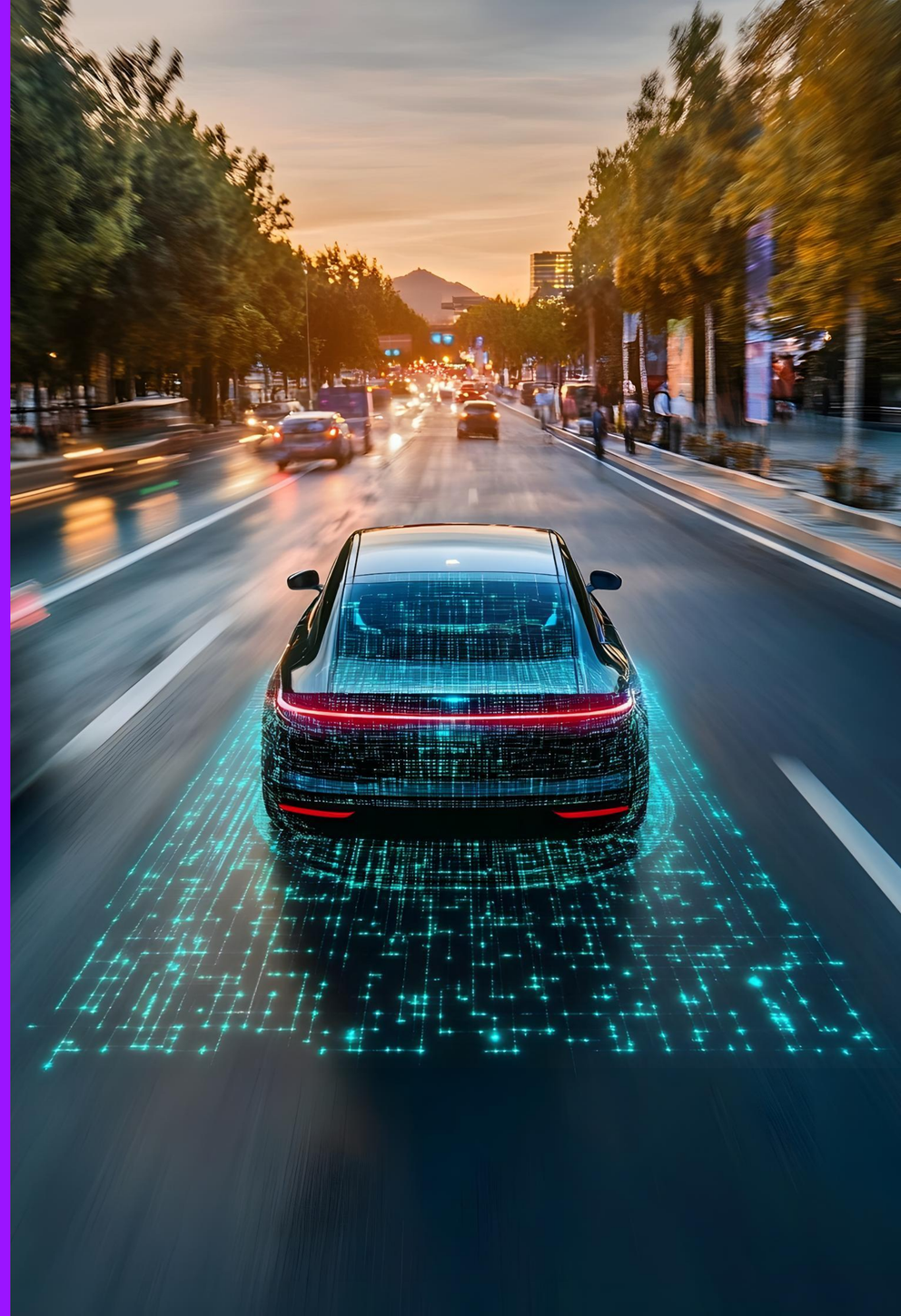
02 **Requirements for sensor materials**
- General Requirements on plastic compounds
- Classification of relevant radiation ranges

03 **Infrared Transparent Materials**
- Properties and application areas

04 **High Frequency Materials**
- Basics and radiation properties

05 **Thermally Conductive Materials**
- Properties and overview

06 **Conclusion**



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Otto Krahn Group

# Experts in plastics and chemistry

| ALBIS | KRAHN | KRAHN CERAMICS | MOCOM | Otto Krahn New Business |
|---|---|---|---|---|
| Distribution of thermoplastics | Distribution of specialty chemicals | Technology partner for ceramic materials | **Compounding of thermoplastics** | Otto Krahn business incubator |

Otto Krahn Group

Defines strategic guidelines, drives innovation and new business areas and assumes the role of a professional service provider.



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Facts & figures

# More expertise

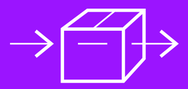
**50**
years of experience & know-how in compounding

**> 5,000**
customers direct or via distribution

**750**
employees

**4,000**
products available, global specifications

**> 1,000**
product development requests per year



**> 11,000**
production process orders per year

**5**
productions sites (DE, CN, US)

**48**
global compounding-lines

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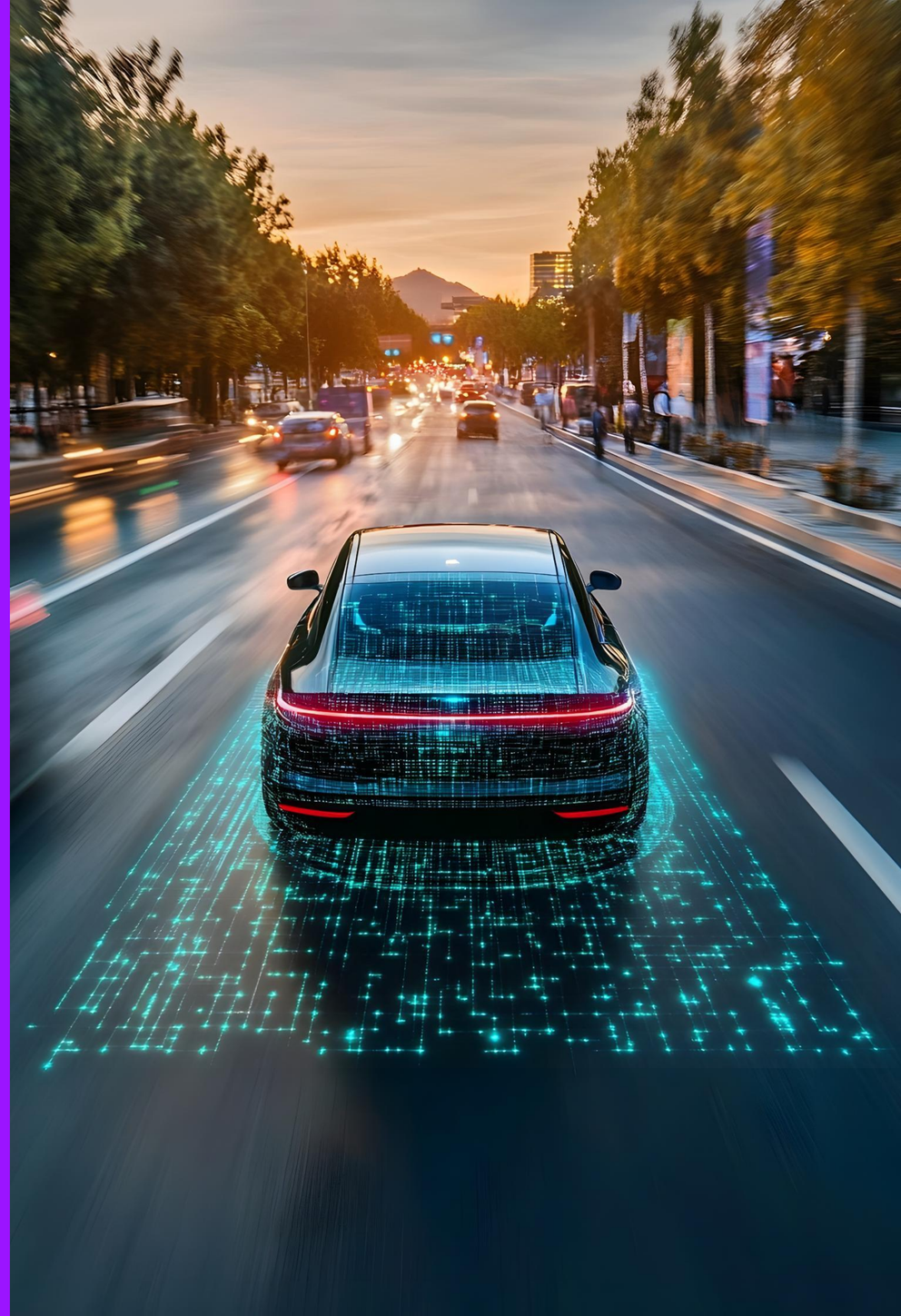

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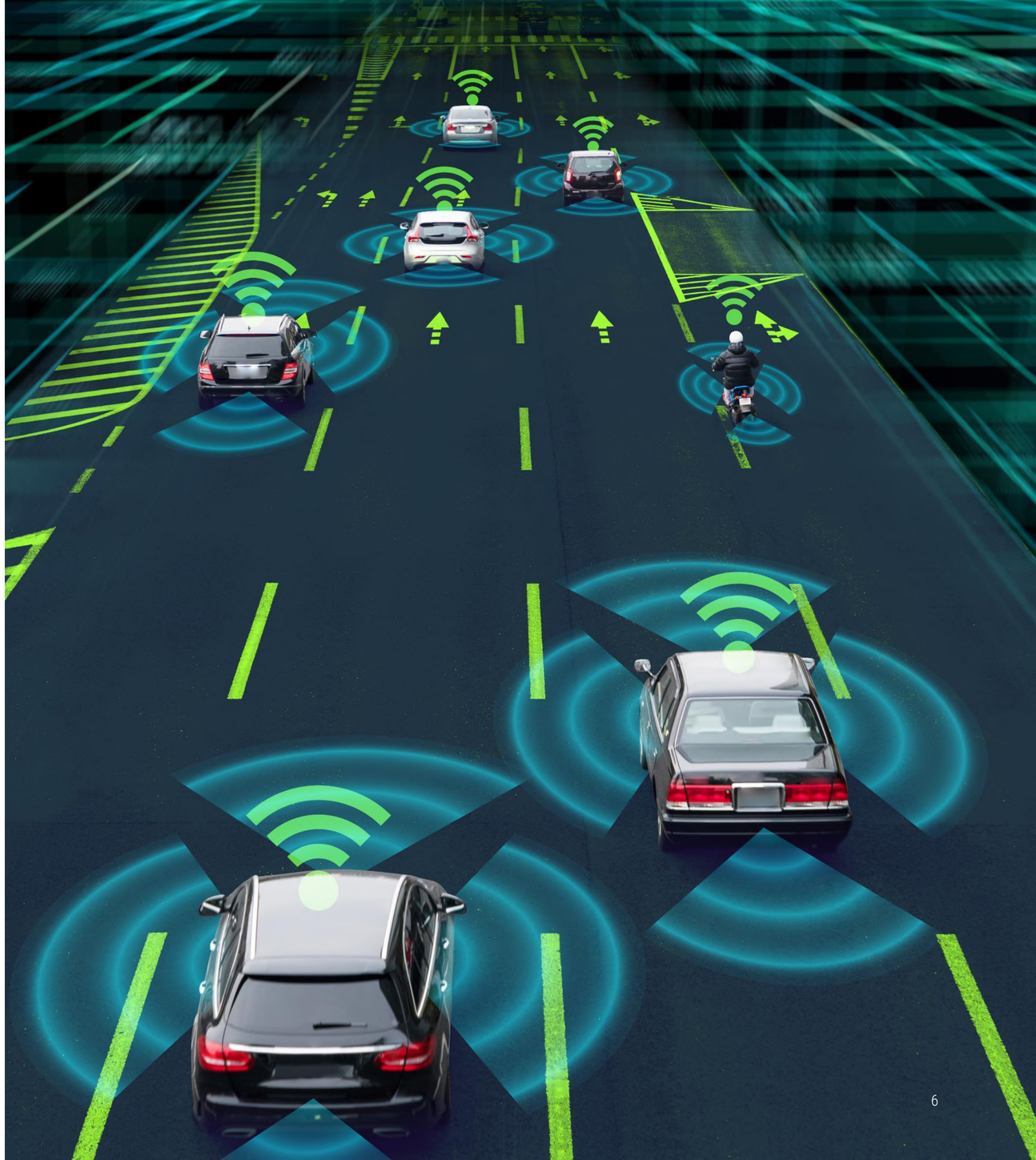
# Requirements for sensor materials

## Materials in sensor application needs distinct properties with the focus on:

- **Permeabilities for radiation**
  - Infrared radiation
  - Radar radiation
- **Environmental stability**
- **Esthetic appearance**
- **Functionality**
  - Conductivity or isolation properties
  - Mechanical properties





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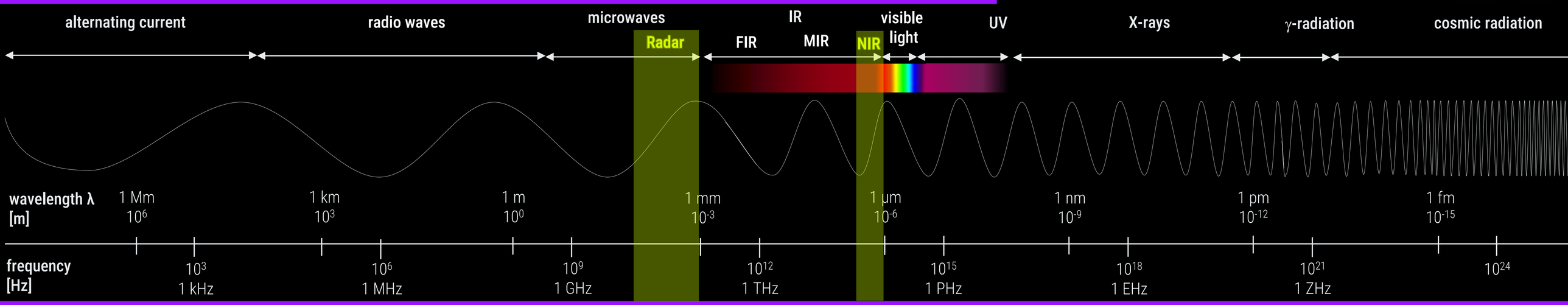
# Relevant radiations for sensor applications

## Mocom sensor materials are focused on two main radiation areas:

- **Radar radiation:**
  - Usage: radar sensors
  - Properties: blocking or transparent for radar radiation in combination with other functionalities like environmental stability, etc.
- **Infrared (IR) radiation:**
  - Usage: IR-cameras, IR-sensors, LiDAR
  - Properties: high transparency in IR radiation, no transmission in visible light, deep black appearance



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Introduction

# General requirements based on application area

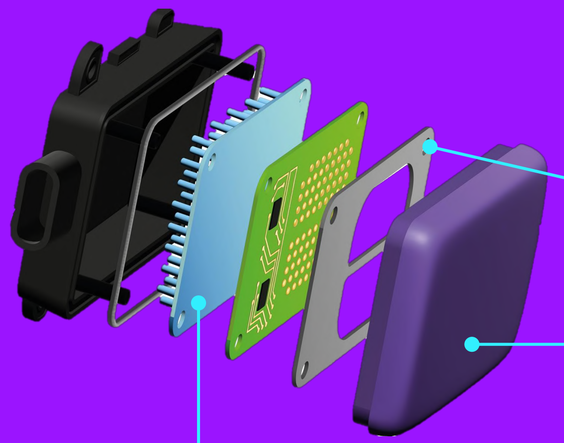
## Materials for sensor application can be divided in two product classes:

- **Radiation sensitive:**
  Depending on the radiation frequency the product requirements arise, such as:
  - IR radiation: IR transparent, blocking for visible light, deep black appearance
  - Radar radiation: transparent or blocking & add. functionalities
- **Functionality driven:**
  - Thermal conductivity: electrical insultation or electrically conductive
  - Environmental stability: UV, etc.
  - Mechanical requirements: stiffness, impact strength, etc.
  - Optical properties: transparency or opacity

### 03. Infrared Transparent Materials:

- Infrared transparent
- deep black appearance

➢ **Alcom® LIR**



### 04. High Frequency Materials:

**Middle plate:**

- Radar absorbing

**Front plate:**

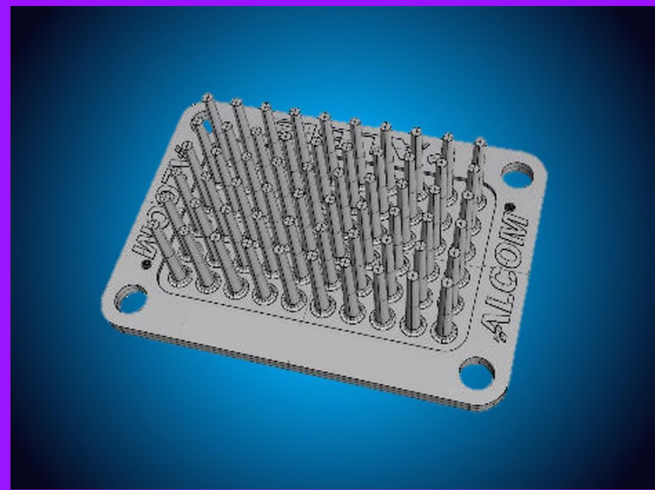
- Radar transparent

### 05. Thermally Conductive Materials

**Heat sink:**

- Thermally conductive

➢ **Alcom® TC**

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# 03.

# Infrared Transparent Materials

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Introduction

# IR-transparent materials for automotive sensor technology

## Infrared sensors places special demands on the materials:

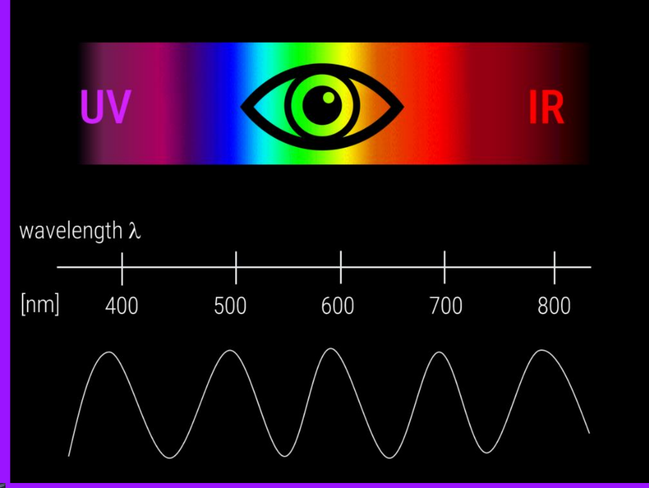
- Nonvisible cover of technique equipment: visible light
- Full transmittance in defined radiation area: infrared radiation

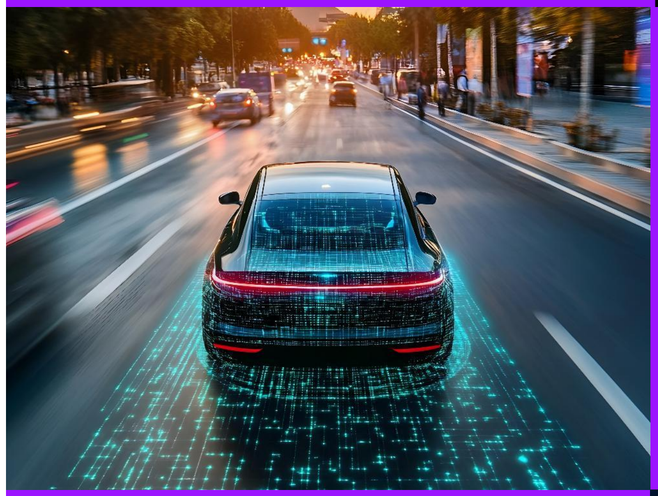
## Alcom® LIR offers a unique property profile:

- **High** transmission for **IR radiation**
- **No** transmission in **visible** spectrum
- **Deep black** appearance
- **Low** haze > 780 nm

## Infrared (IR) light is electromagnetic radiation:

- Visible spectrum: wavelength 380 nm – 780 nm
- IR radiation: wavelength **780 nm – 1 mm** (Frequency: 430 THz – 300 GHz)
- Alcom® LIR focused on **NIR** (**780 – 1400 nm**)



## Requirements for materials:

- Sensor nonvisible for human eye
- Full radiolucency in the working area

## Possible Applications:

- IR camera covers
- Driver assistance applications
- LiDAR covers

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Function Example

# Driver Assistance Applications

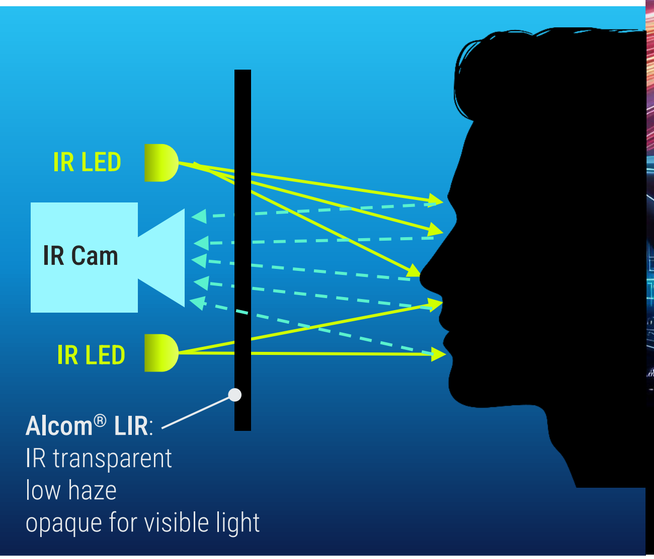
## Driver Monitoring System

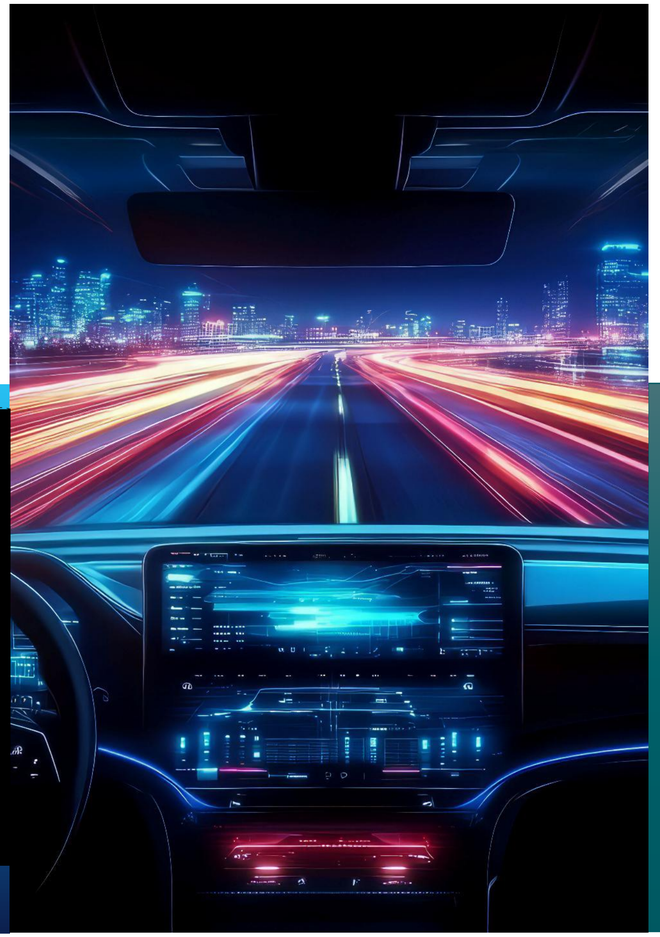
**Visible light could jam the camera performance**

- Is filtered while maintaining high transparency in IR-spectrum

**Mostly cameras / sensors are hidden behind black panel lenses or covers**

- Placed for example in the instrument panel



## Driver Assistance with LiDAR

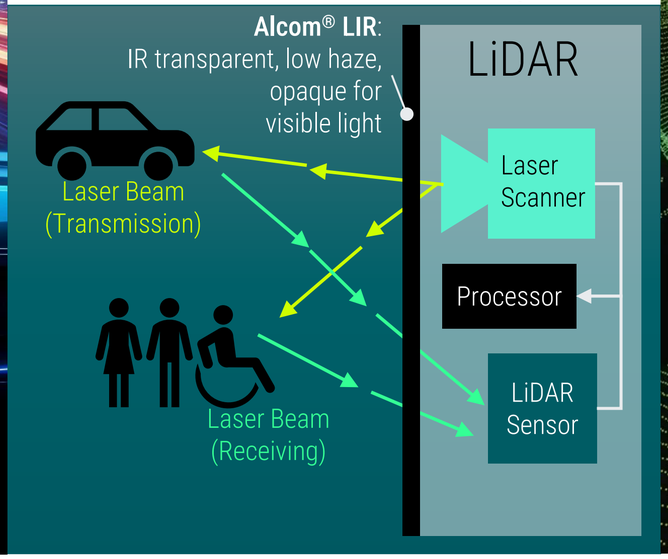
**Visible light could jam the camera performance**

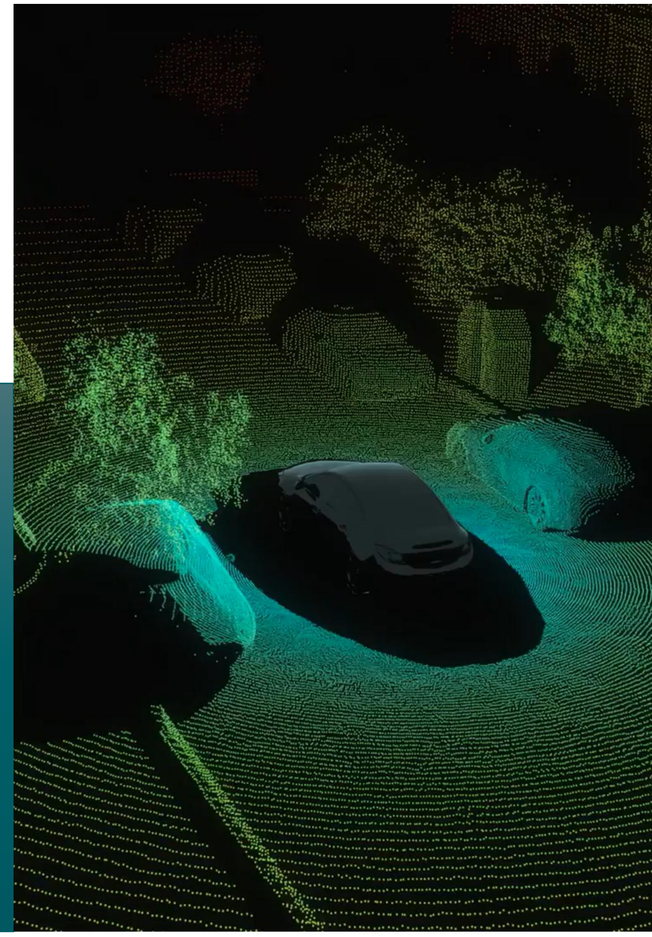
- Is filtered while maintaining high transparency in IR-spectrum
- LiDAR work area (mainly): 780 – 1400 nm wavelength

**Maximum optical clarity**

- Very low haze:

**Cameras / sensors are hidden behind black panel**



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# 04.

# High Frequency Materials

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Basics

# Measuring of HF wave permeability

## Characteristic values:

**permittivity: $\varepsilon_r$ → transmittance**

**loss factor: tan$\delta$ → damping**

## On a component invaded radiation is separated in:

Reflection

Absorption

**Transmission** → measured value

**The lower the permittivity the better the radar transparency: $\varepsilon_r > 1$**

**The higher the permittivity the more radar blocking: $\varepsilon_r \gg 1$**

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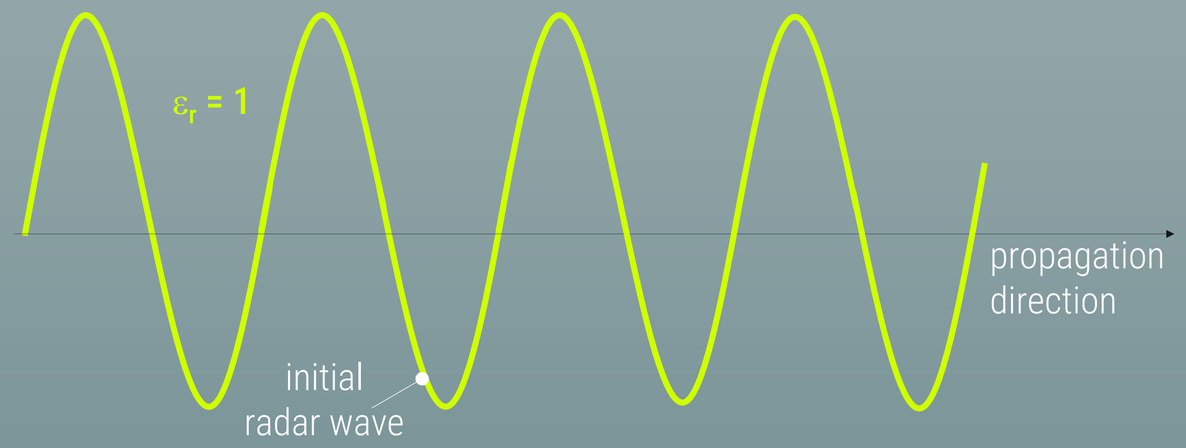
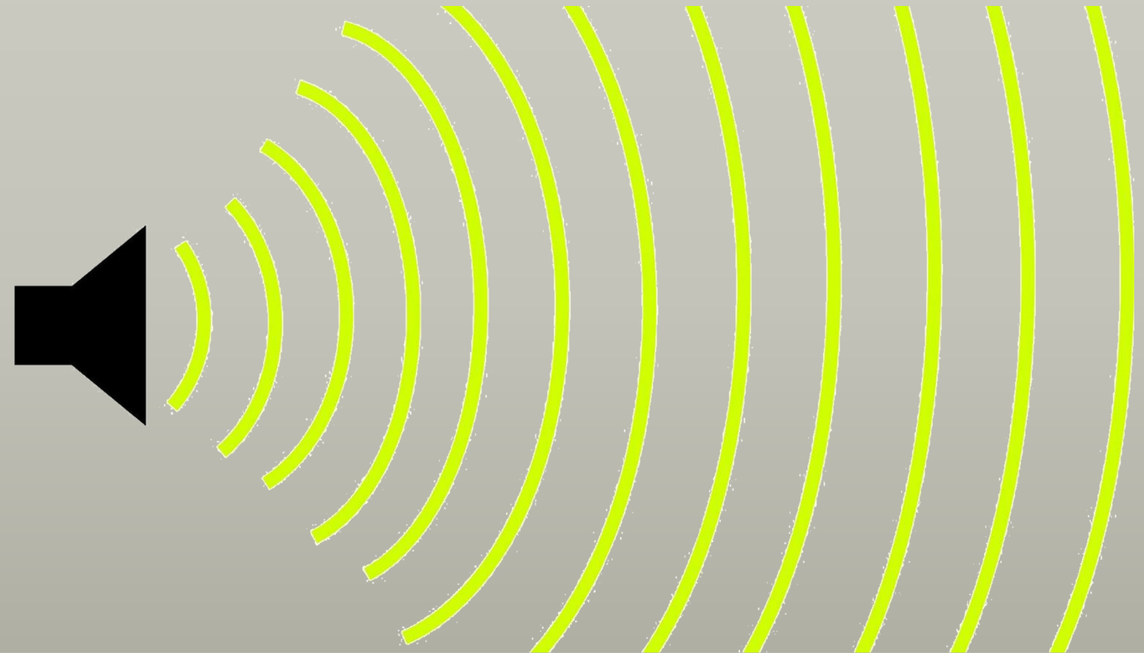
Curve oscillation is changed by passing through a material because of the difference in permittivity of air ($\varepsilon_r = 1$) and the material ($\varepsilon_r > 1$)




Principle explained using the example of a loudspeaker



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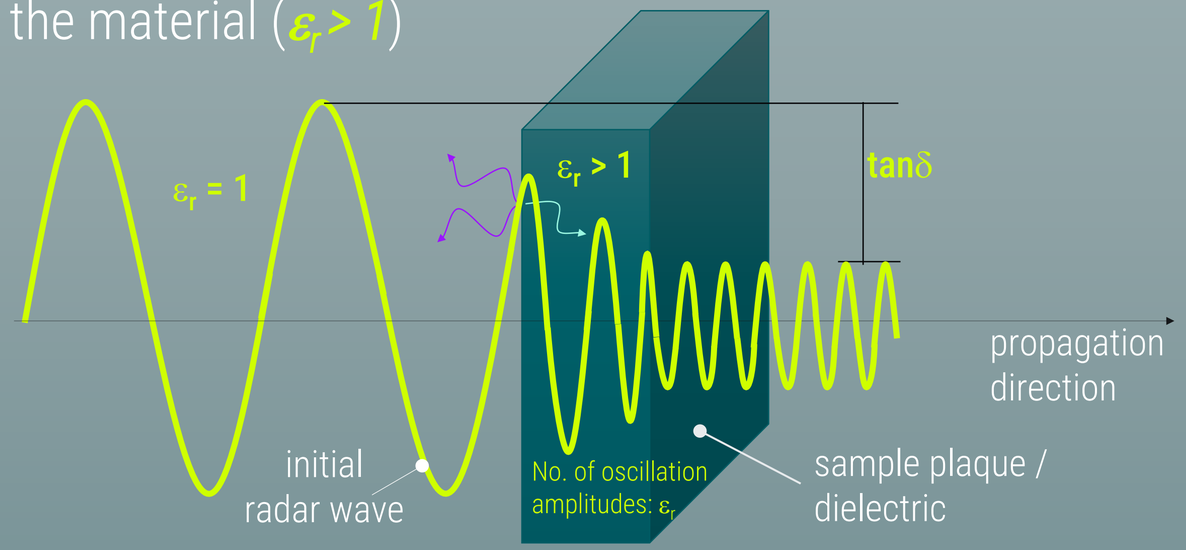
Curve oscillation is changed by passing through a material because of the difference in permittivity of air ($\varepsilon_r = 1$) and the material ($\varepsilon_r > 1$)

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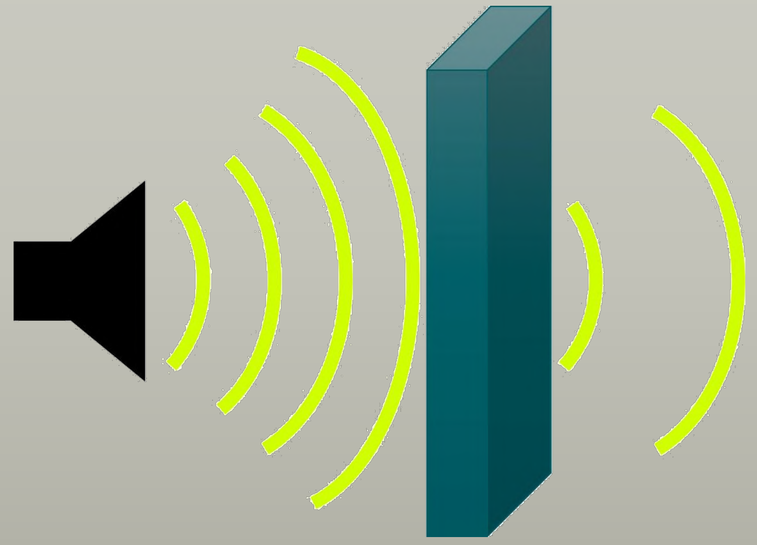

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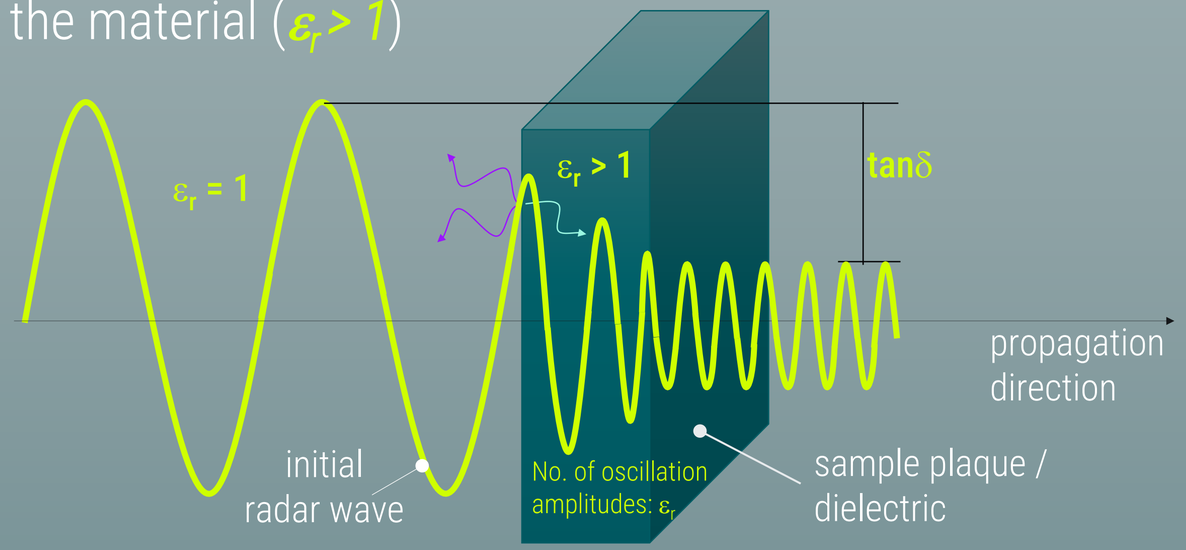
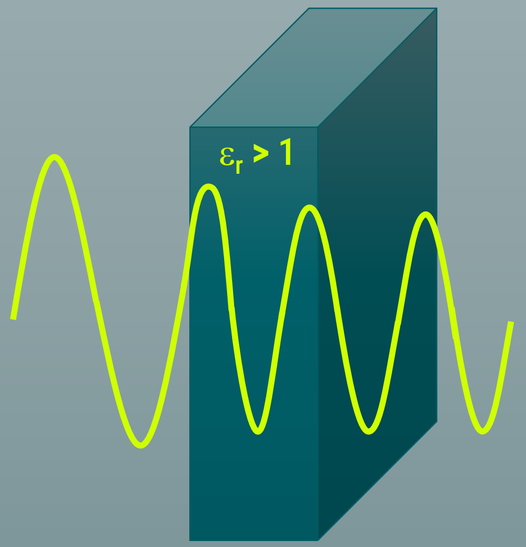
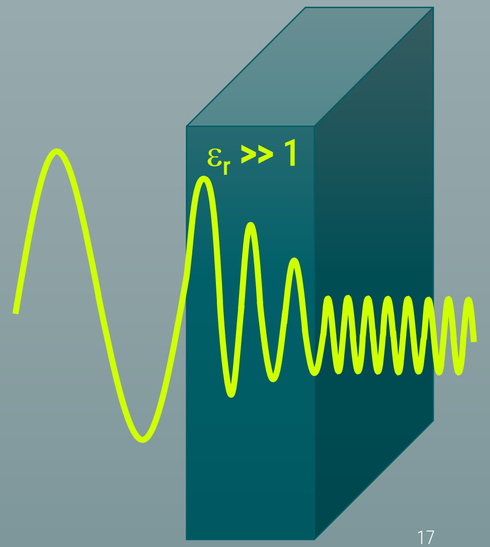



Radar transparent material:




Radar blocking material:

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Influencing Factors

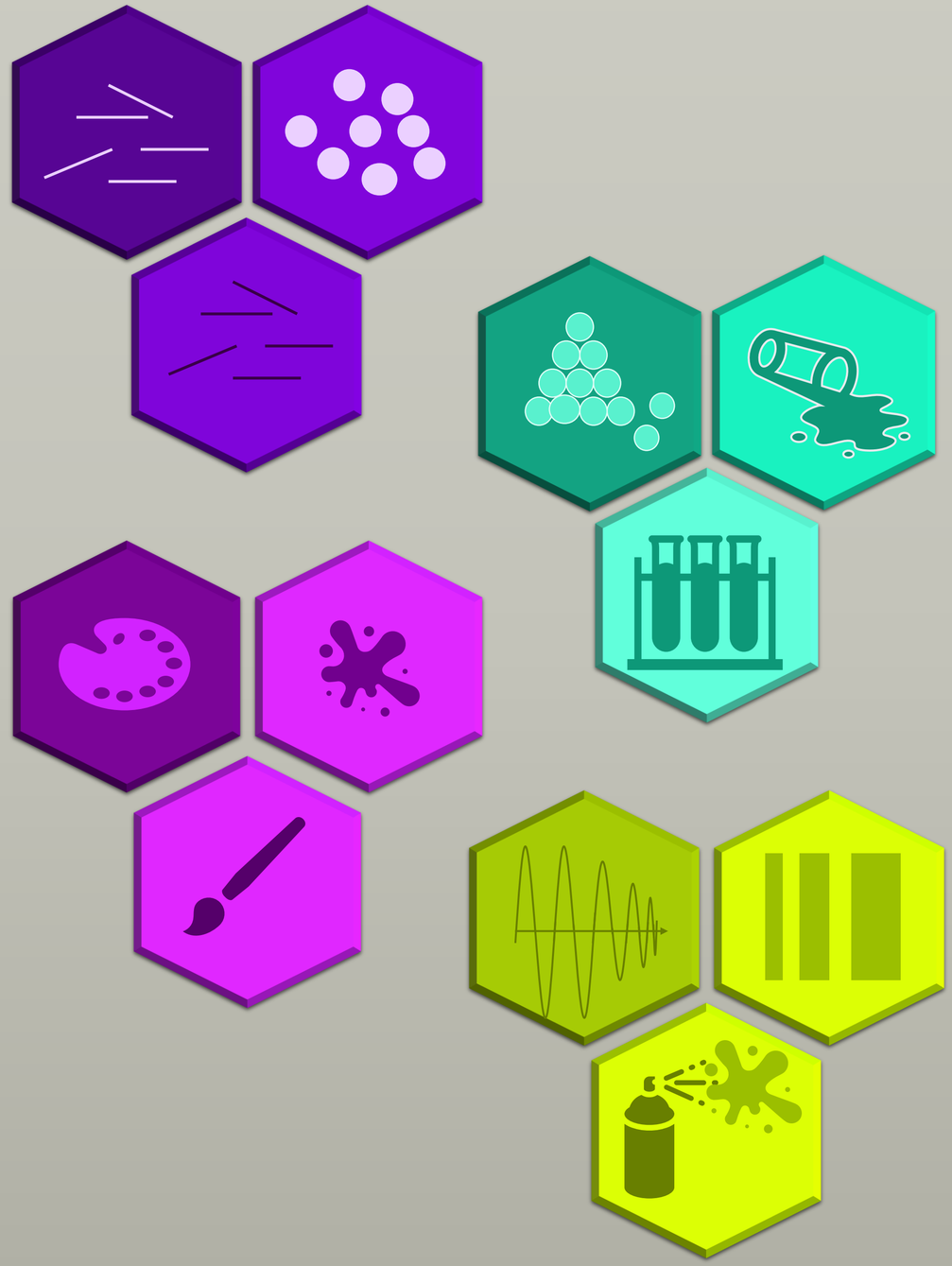
# Radar properties of plastics

## There are many influencing factors on permittivity of plastics:

- Polymer
- Filler, additives, colorants and their distribution in a compound
- Frequency
- Wall thickness (big effect on tanδ for high frequencies)
- Surface finish

## Compounds can be customized for radar requirements, and even integration of functions is possible with a suitable combination of:

- Polmer & Filler
- Colorant & additive system



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Summary High Frequency Materials

# Compounds for HF Applications

## High frequency properties of plastics are influenced by many factors:

- Suitable polymers
- Fillers, additives and colorants
- Frequency and wall thickness of the part

## With a suitable combination of polymer, filler & additives HF requirements with a variety of functionalities are achievable:

- Alcom® Specialties
- Altech® / Altech NXT® / Altech ECO®

## Customized solutions with targeted requirements can be developed:

- Measurement of permittivity with external lab

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# 05.

# Thermally Conductive Materials

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Introduction

# Advantages at a glance

**Thermally conductive plastics are characterized by the following benefits compared to metals:**

- Low energy consumption
- Low GWP
- Light weight
- Design freedom & function integration

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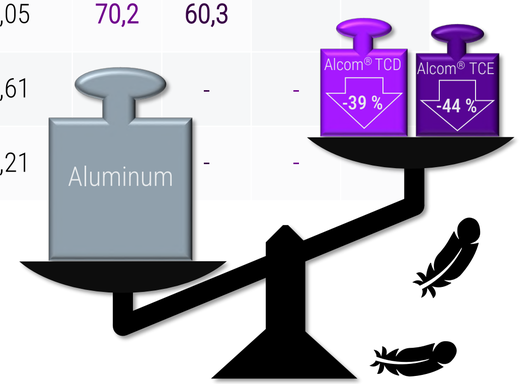
Saving Potential

# Of Alcom® TC compared to Metals

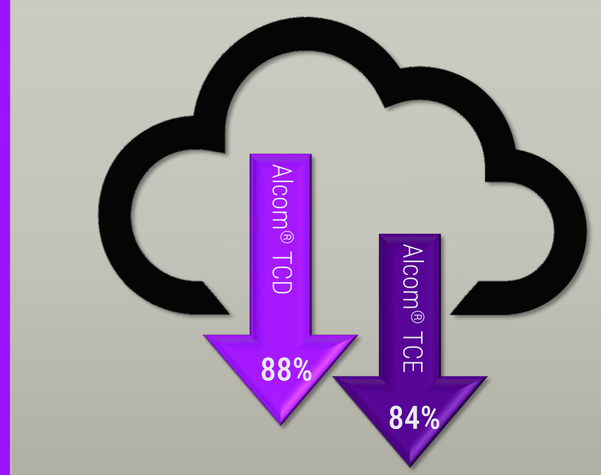
## GWP and weight saving compared to different thermal conductive materials shown on the example of a thermal conductive housing part:

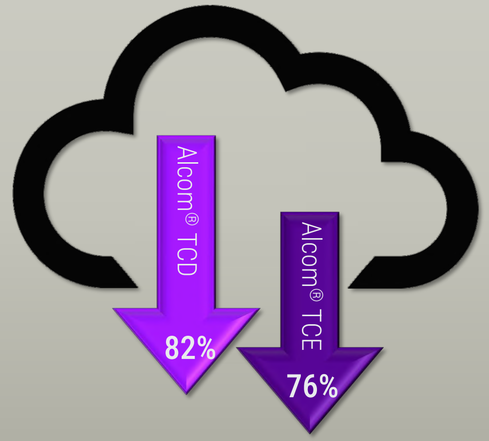
| Material | Density [g/cm³] | GWP [kg CO2 eq. / kg] | GWP of part* [kg $CO_2$ eq. / kg] | GWP Saving* [%] | | Weight Saving* [%] | |
|---|---|---|---|---|---|---|---|
| | | | | TCD | TCE | TCD | TCE |
| **Magnesium – die casting** | 1,74 | 39,5 | 10,31 | 88,3 | 84,4 | 6,3 | 13,2 |
| **Aluminum – deep drawing** | 2,7 | 16,6 | 6,72 | 82,1 | 76,1 | 39,6 | 44,1 |
| **Aluminum – die casting** | 2,7 | 10 | 4,05 | 70,2 | 60,3 | | |
| **Alcom® PA66 910/32.1 GF8TCE8** | 1,51 | 7,1 | 1,61 | | - | - | |
| **Alcom® TCD PA6 5060 FR 16089** | 1,63 | 4,93 | 1,21 | | - | - | |

*related to a component with a volume of 150 cm³



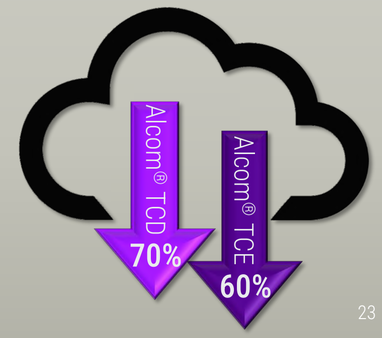

**GWP saving vs. magnesium die casting**




**GWP saving vs. Aluminum deep drawing**

**GWP saving vs. Aluminum die casting**

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Function Example

# Efficient thermal management in Sensor applications

## Alcom® TCD combines the unique functionalities of:

- Thermal management
- Insulation material
- Housing (indoor / outdoor)
- Cost reduction over metal parts
- More efficient production over metals

## … and fulfills customized the most diverse requirements, like:

- Flame retardancy
- Paint ability
- Stability against Hydrolysis
- UV-stability
- Radar absorbance


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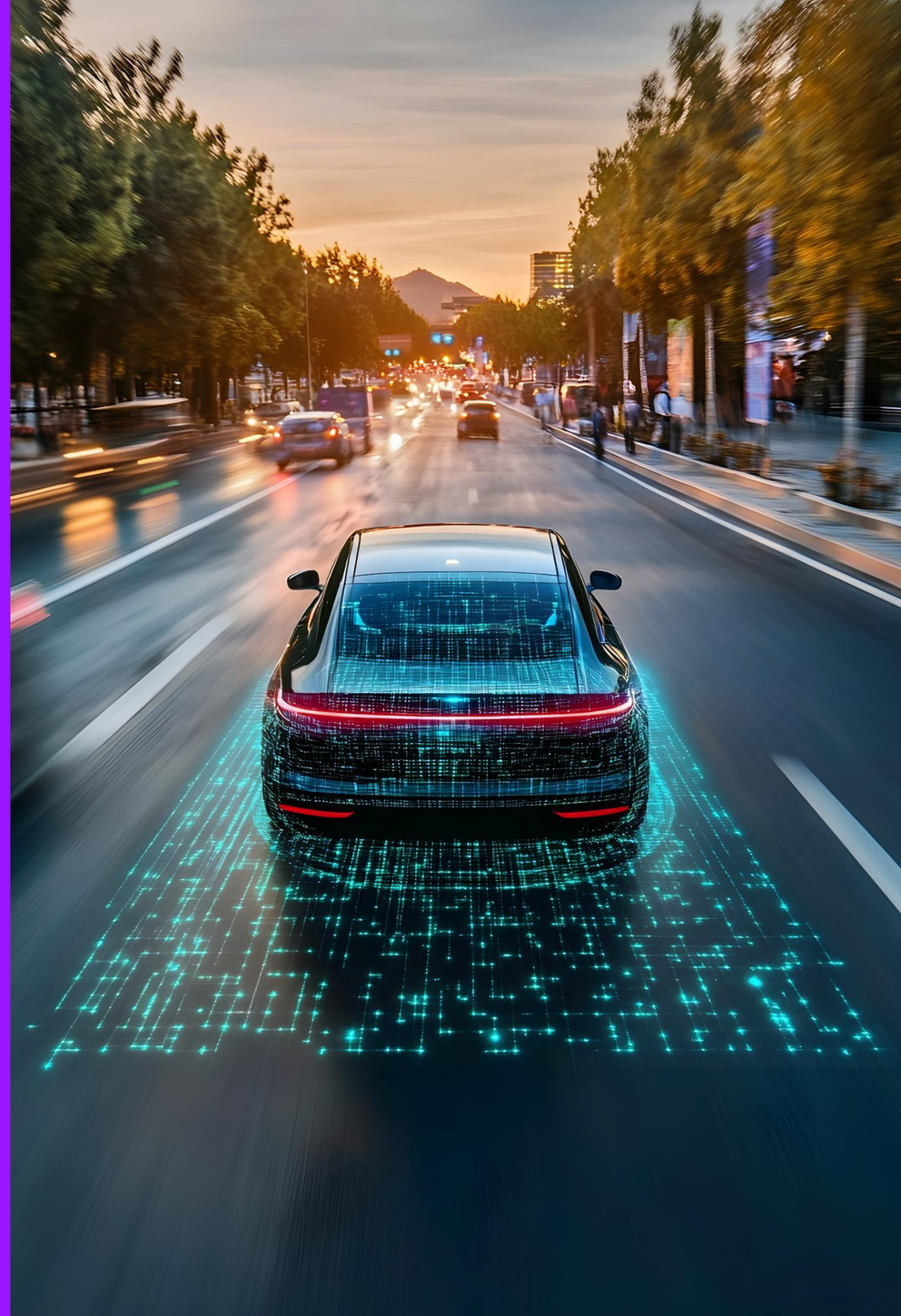

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Conclusion

# Plastics in sensors: material with great potential

## Plastics used in sensor applications needs special properties like

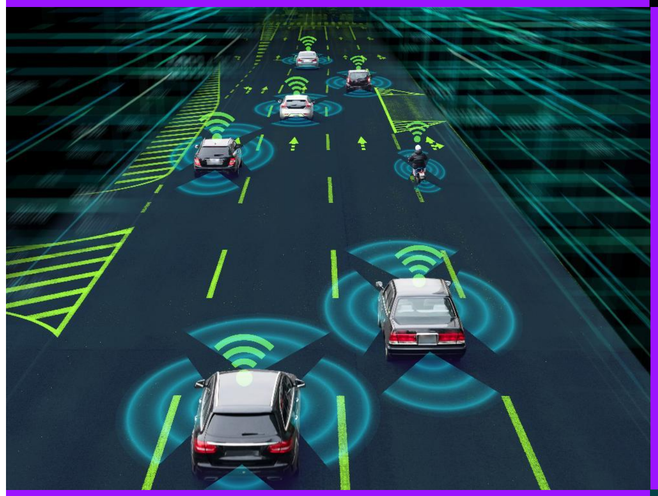
- Radiation sensitiveness
- Functionality in special areas like thermal conductivity

## Diverse properties in radiation sensitive applications can be customized with right coloration, filler and polymer combination

## The usage of plastics in sensor applications can have positive effects, like:

- **Alcom® TC**: Cost and $CO_2$ savings by metal replacement
- **Alcom® LIR**: Deep black appearance and masking of electronics
- **HF Materials**: Radar absorbance and function integration like thermal conductivity

IR Transparent Materials



High Frequency Materials

Thermally Conductive Materials

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# Thanks!

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