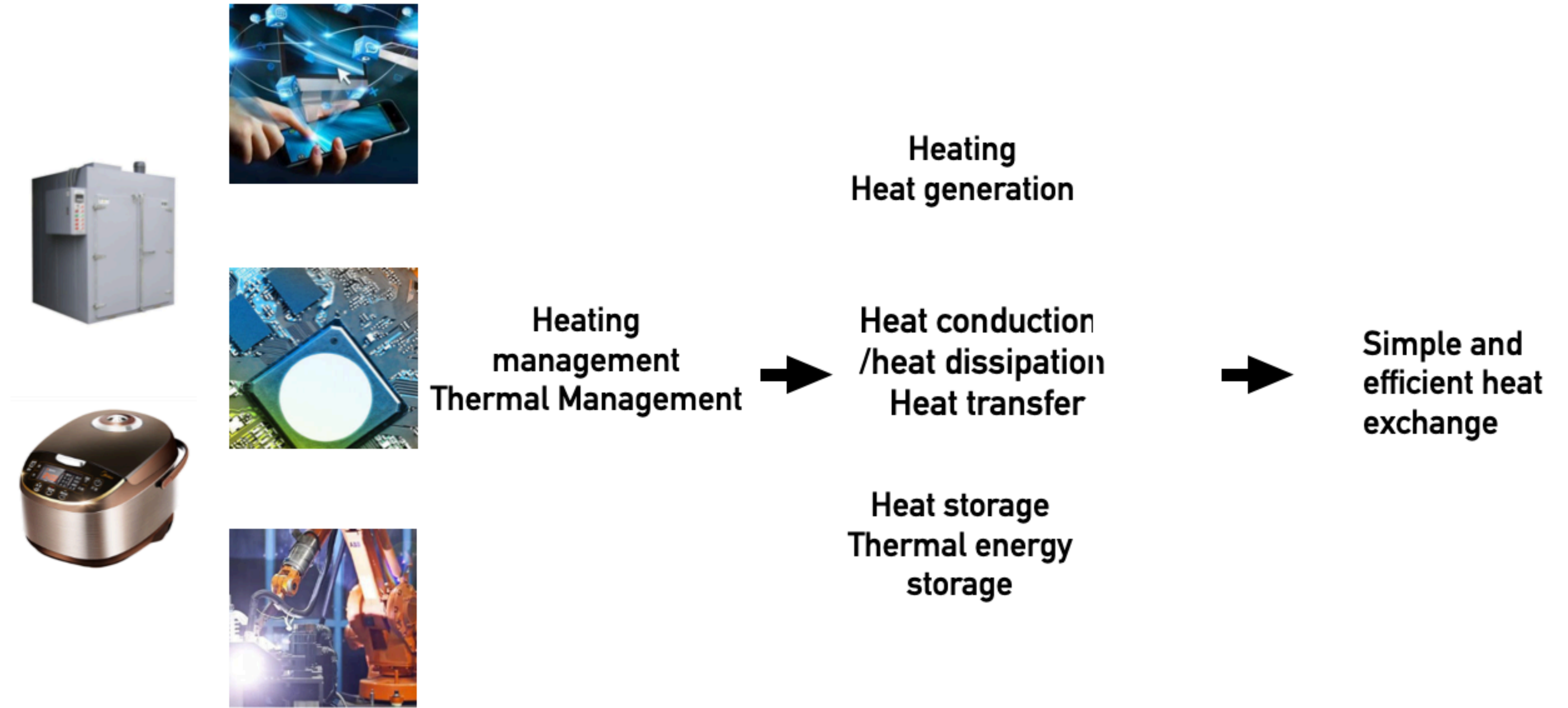




Graphene Thermal Radiation Coating Material Description

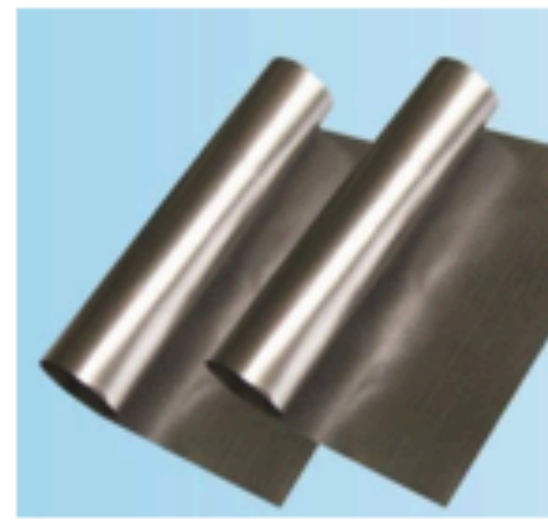


Heat exchange

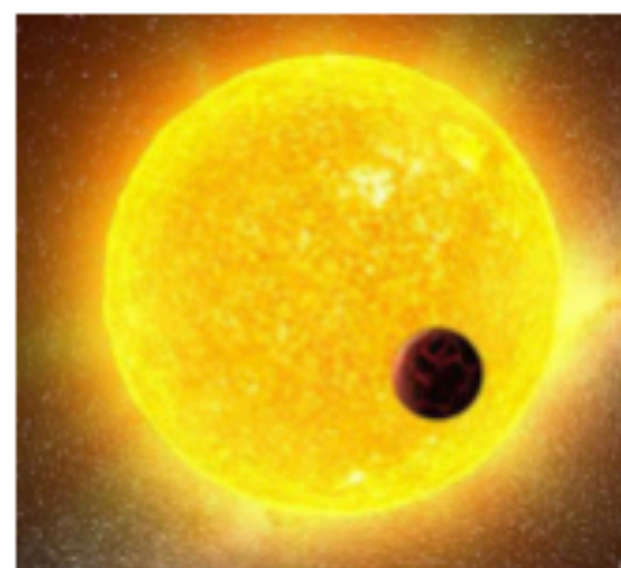
Heat Conduction

Heat convection

Heat radiation



Relying on multiple factors such as media, interface, environment, and systems, improving performance requires combining the influence of various factors, and the potential for improvement is limited.



The heat energy is directly converted into electromagnetic wave radiation. The process is not affected by the medium and the environment and is only related to the surface state and temperature of the substance.

Heat radiation is an independent heat exchange channel, which can further enhance the heat exchange effect .

Equation of
Heat radiation power

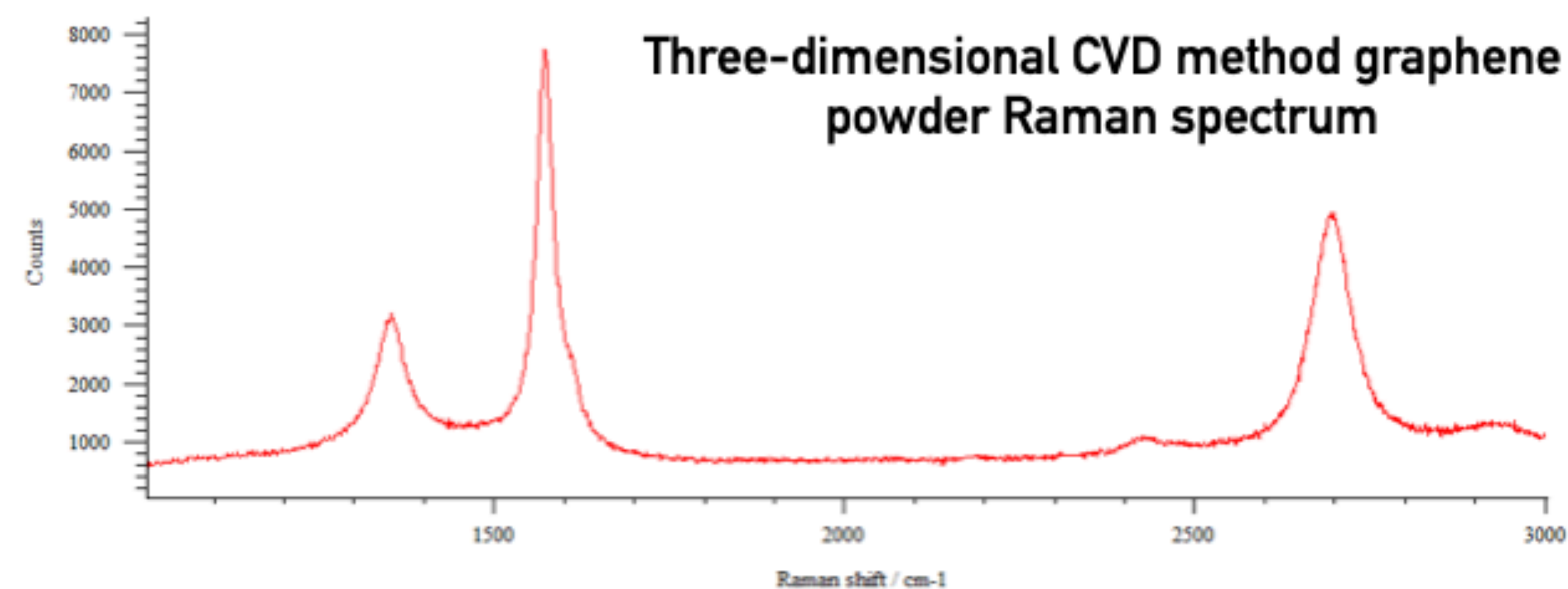
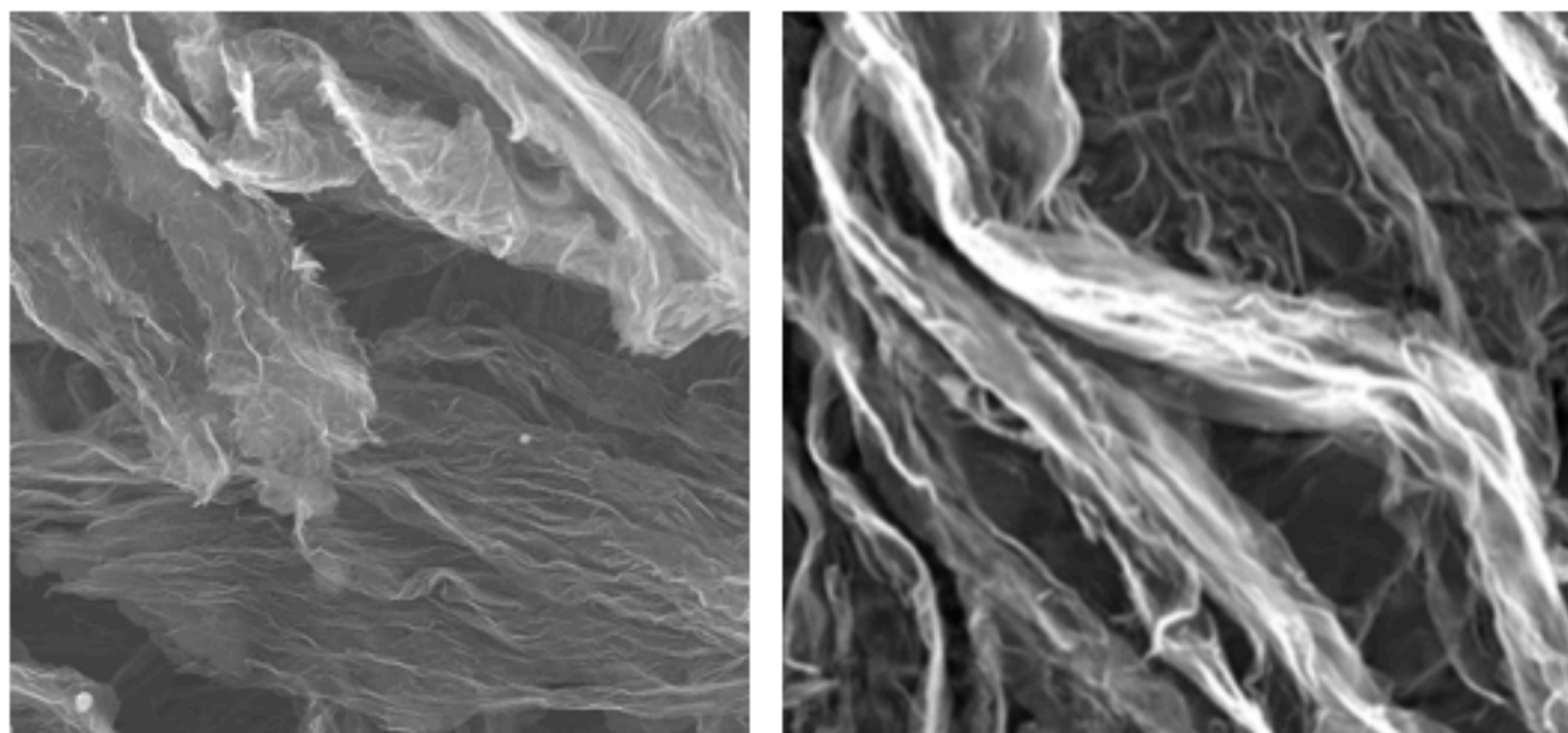
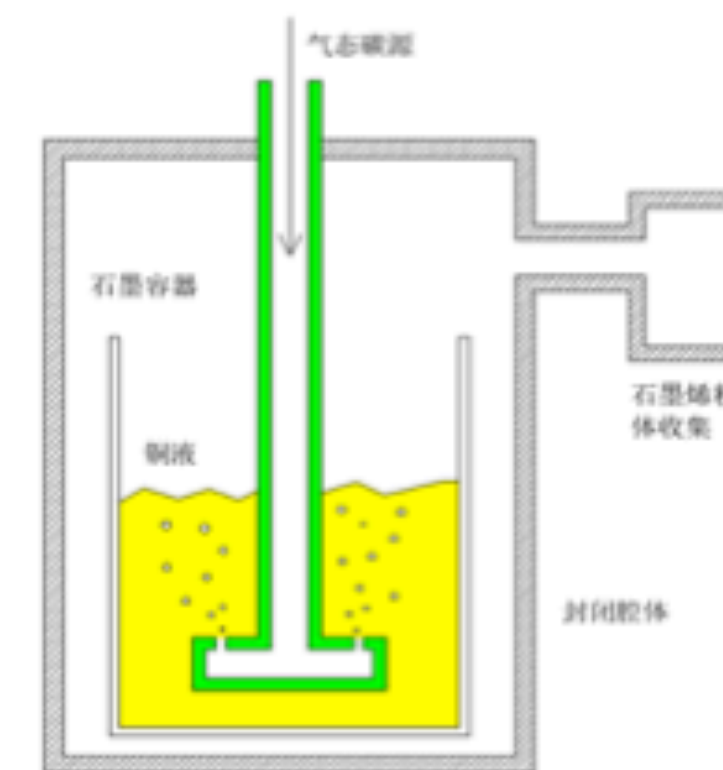
$$P = \delta S \varepsilon T^4$$

P: power, **δ**: constant, **S**: area, **ε**: Radiation coefficient, **T**: temperature

The larger the thermal radiation area, the closer the thermal radiation coefficient to 1, and the higher the surface temperature, the more significant the thermal radiation effect in heat exchange.

Graphene filler

- ◆ The industry's unique 3D CVD method to prepare graphene powder
- ◆ The powder has excellent structural integrity and crystallinity
- ◆ High thermal conductivity, thermal radiation coefficient close to the theoretical limit
- ◆ Contains rich folds, providing a large amount of heat radiating surface
- ◆ The performance is far better than the graphene powder prepared by the conventional method



Modified inorganic medium water-based system

- ◆ Excellent compatibility with graphene
- ◆ Temperature resistance above 500°C
- ◆ Resistance to cold and heat shock
- ◆ No combustible material, Class A1 flame retardant
- ◆ Excellent weather resistance, aging resistance
- ◆ Compared with organic media, it has better thermal conduct
- ◆ No VOC and other undesirable volatiles

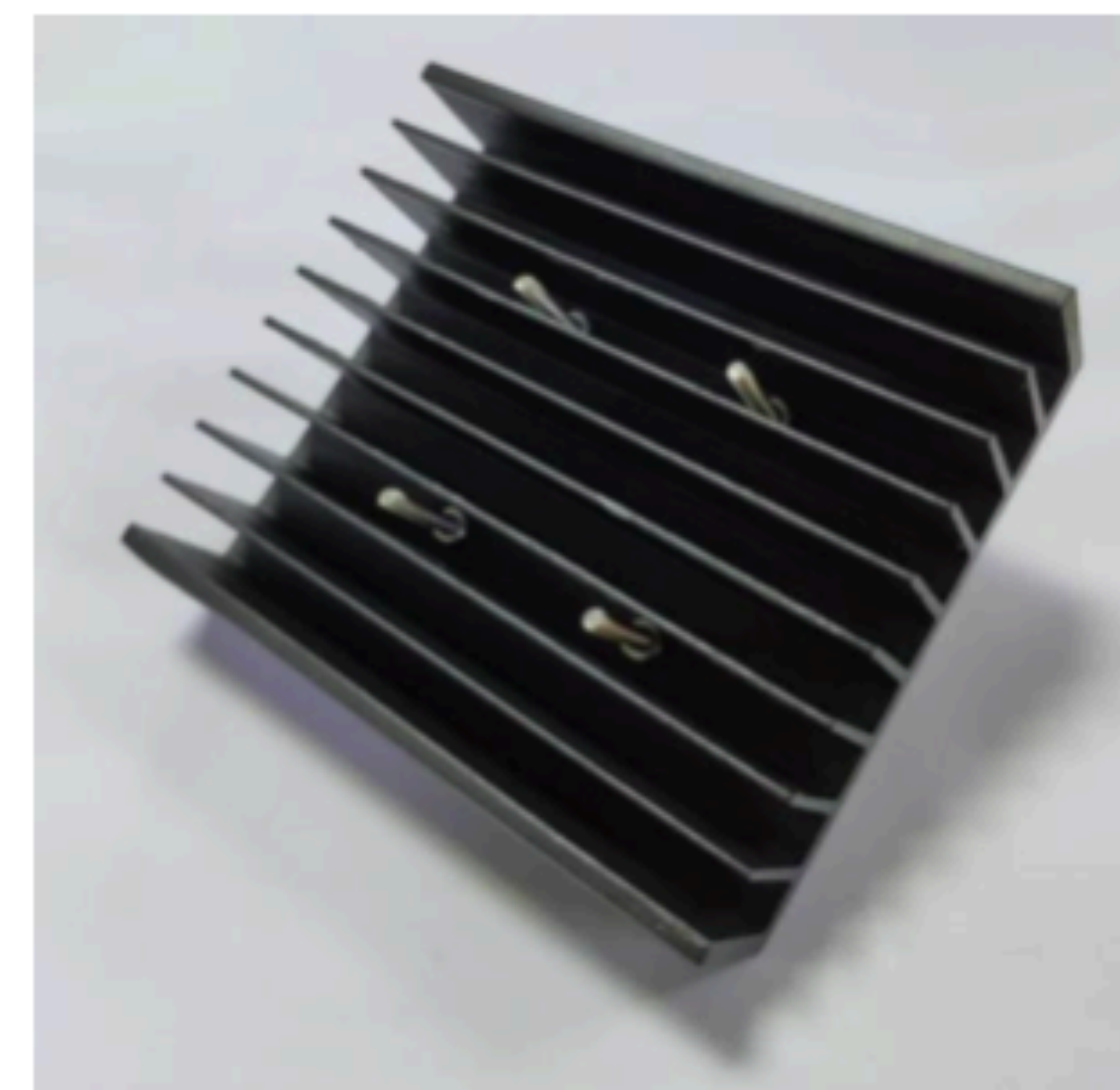
Graphene
(filler)

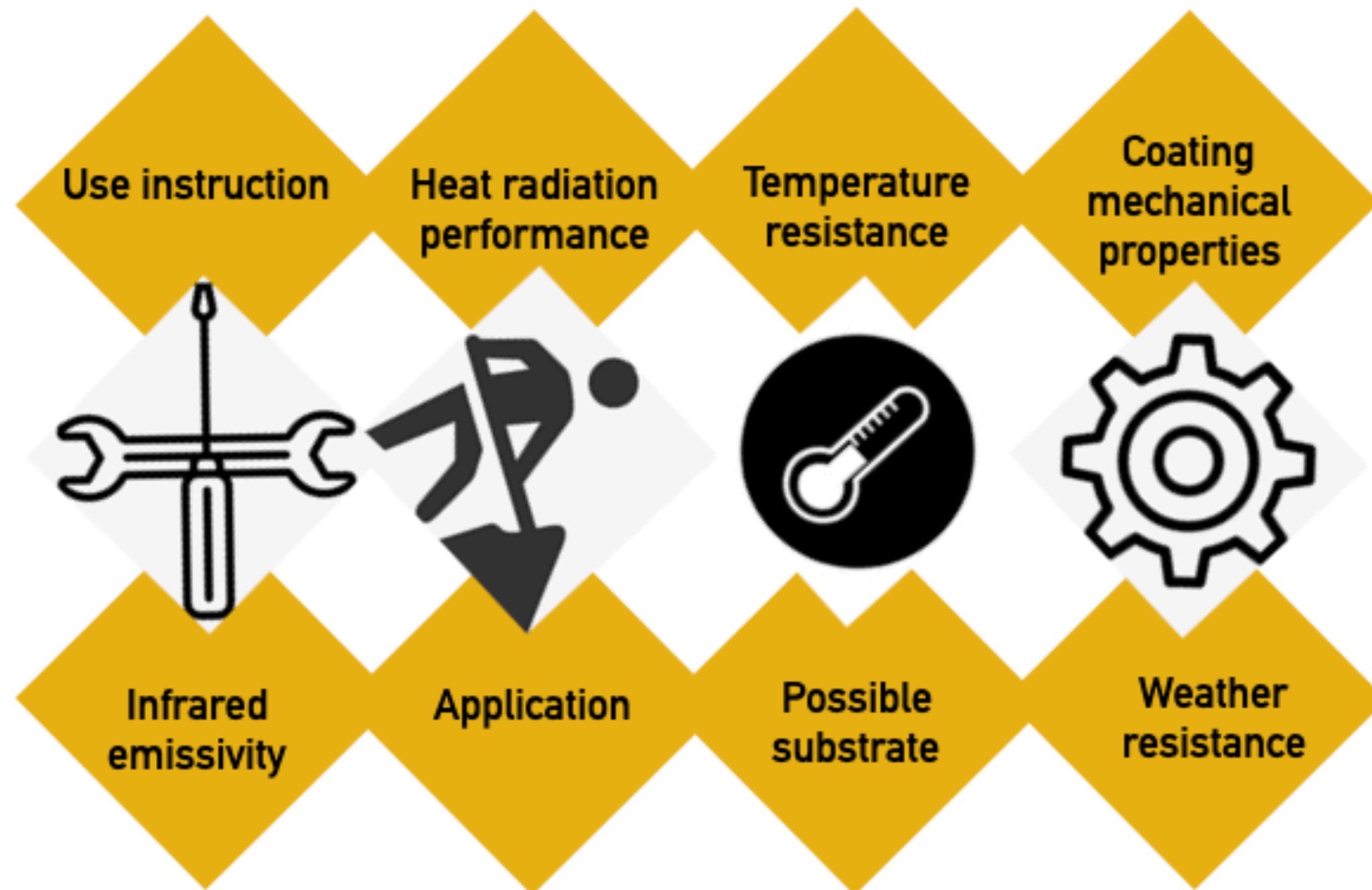
Modified inorganic
medium
(Substrate)

Aqueous system
(Solvent)

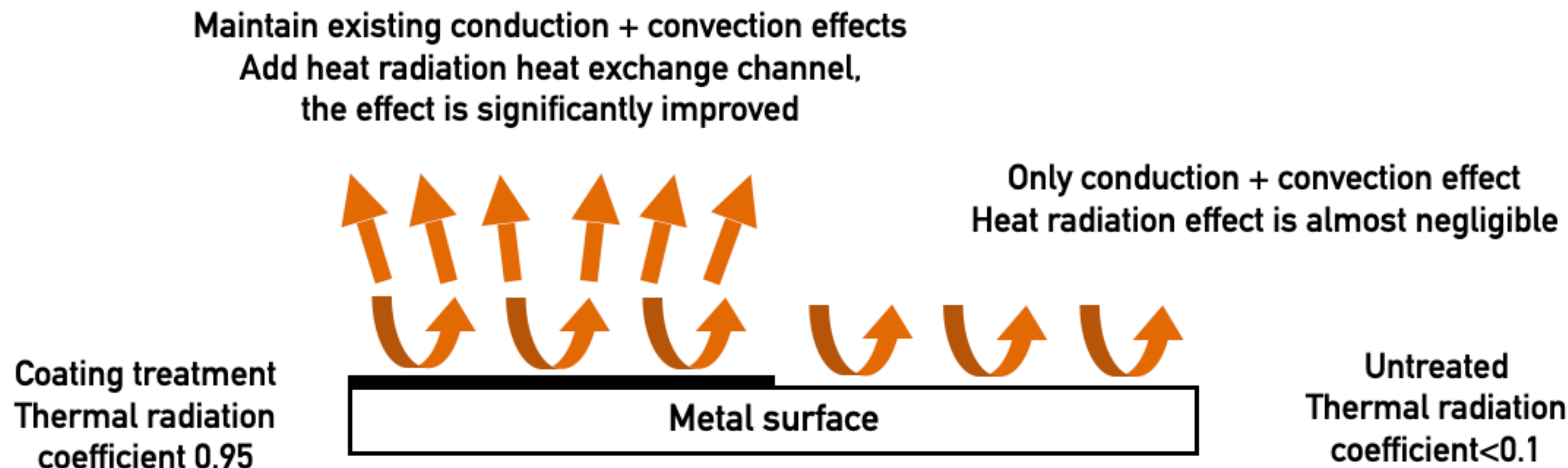
Heat radiation/heat dissipation coating

Coating for improving heat exchange performance
using heat radiation effect





- **Use instruction**
Apply the material to the surface that needs to improve the heat exchange/heat dissipation effect to form a coating with heat radiation effect to improve the heat exchange/heat dissipation performance
- **Infrared emissivity**
Infrared heating rate up to 0.95
- **Heat radiation performance**
Heat radiation efficiency increased by 70-80%
- **Coating mechanical properties**
Adhesion level 0, surface hardness 4H, mechanical shock resistance
- **Temperature resistance**
Withstand 500 long-term use environment, -20°C~500°C cold and heat shock
- **Weather resistance**
Resistant to ultraviolet and ozone, one-time spray can be effective for a long time, maintenance-free
- **Application**
Suitable for spraying process, also can be scraped, rolled, dipped, etc.
- **Possible substrate**
Common metal, ceramic, and plastic substrates



Coating microstructure



Graphene network: Provides a large amount of heat radiation area to form a heat conduction network

Inorganic phase of coating: high temperature resistance, provide firm connection, compensate heat conduction



comparison	Company A	Company B	Our product
system	Nano carbon + organic medium	Ceramic + semi-inorganic medium	Graphene + inorganic medium
composition	Aqua/single component	Oil/two-component	Aqua/single component
Ease of use	High	Middle	high
Coating thickness	30-50um	Ca. 100um	10-30um
cost	1,5-2,5 €/m ²	Ca. 3 €/m ²	Ca. 1,5 €/m ²
Coating thermal emissivity	0,8	0,7	0,95
Temperature resistance	<200°C	500-800°C	500°C
Improved heat dissipation/heat exchange performance (120°C, aluminum substrate)	+20%	+15%	+30%

Compared with the existing solutions, the graphene heat radiation/heat dissipation coating provided here has the characteristics of high ease of use, low use cost, good temperature resistance, high heat radiation coefficient, and significant improvement of heat dissipation/heat exchange performance.



IGBT chips

Improve performance

Improve system performance

Extend system life



Household appliances

Develop new markets

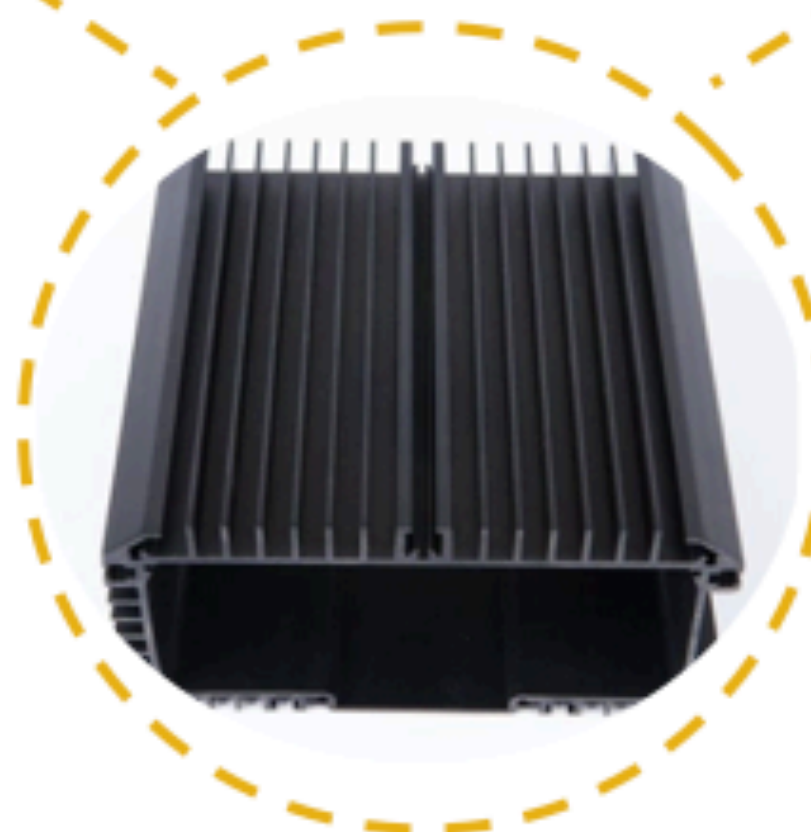
Provide differentiated products
Facilitate marketing and promotion activities

Chassis or heat sink

Cost optimisation

Simplify system design

Reduce material usage



**Communication
base station**

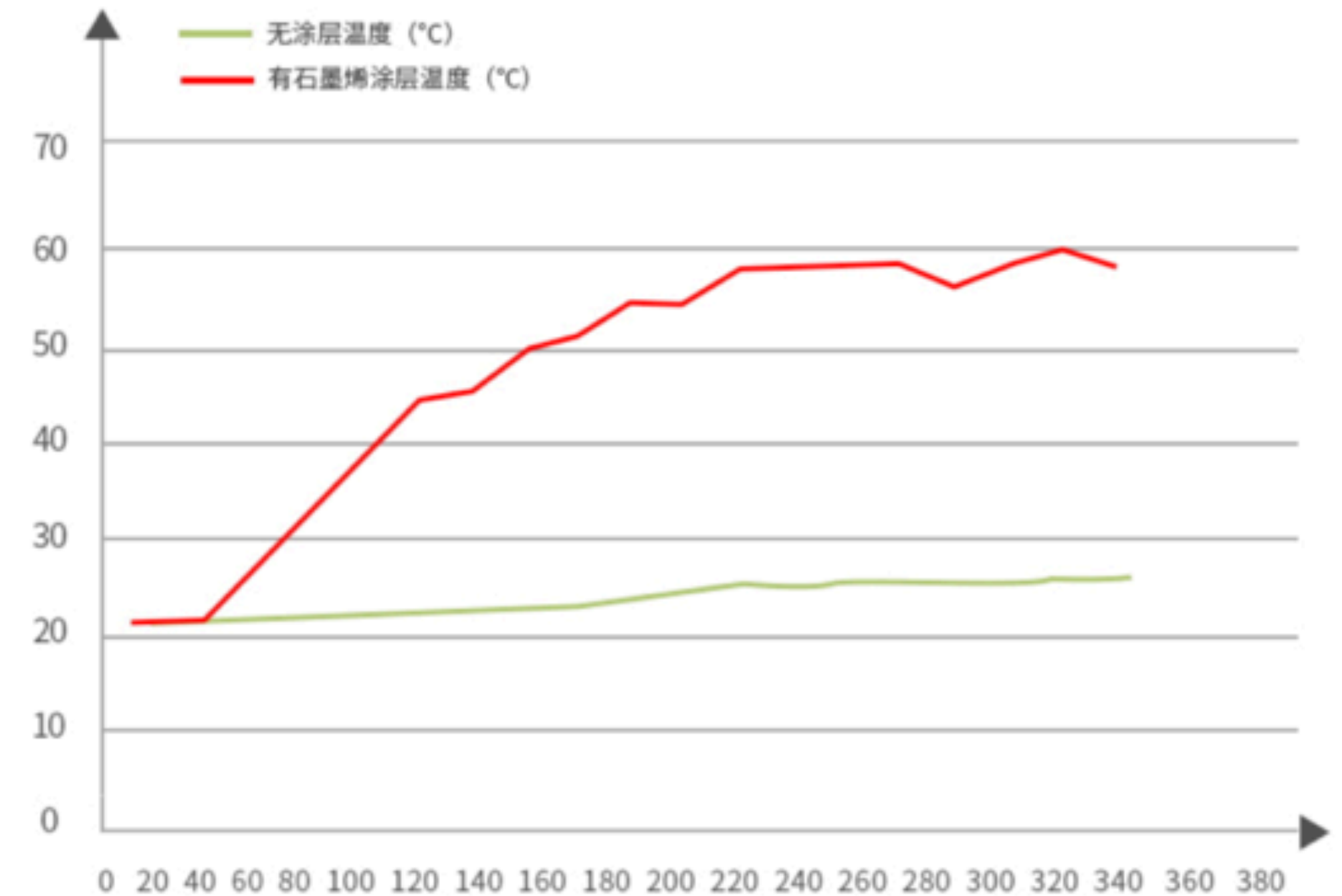
Solve rigid demand

Meet the needs of miniaturization of
electronic information equipment



Summary

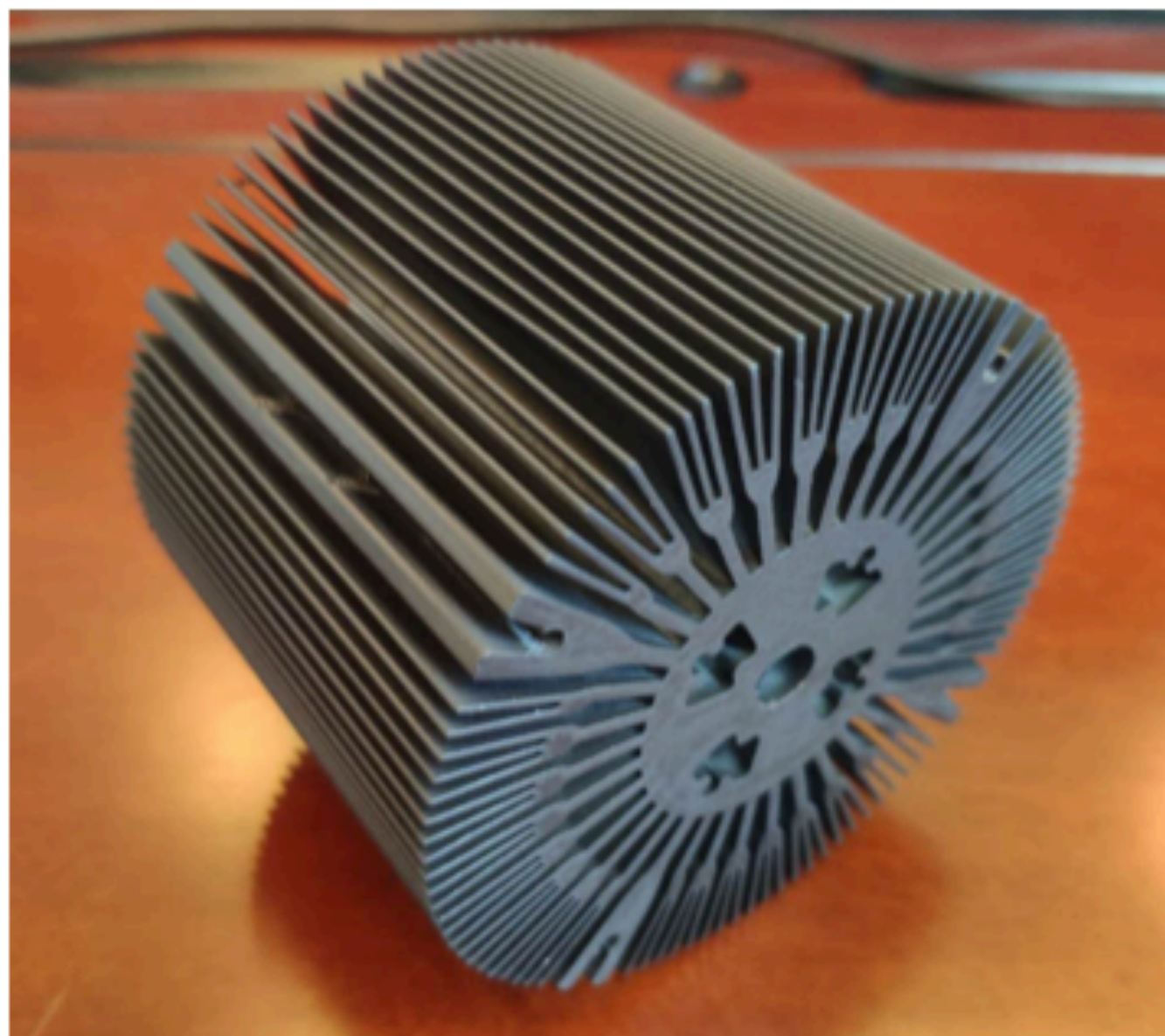
- ❑ **Material:** Unique CVD graphene powder + inorganic dielectric system
- ❑ **Performance:** Significantly improve heat exchange performance, high temperature resistance (500°C), A1 flame retardant, high weather resistance
- ❑ **Maturity:** After nearly 1 year of testing, a reliable production has been achieved
- ❑ **Application:** Help customers improve product performance, optimize costs, solve application pain points, and enhance product competitiveness
- ❑ **Potential:** The application involves industrial heat exchange, component heat dissipation, electrical equipment thermal management, household appliances and other fields



*数据来源于上海市质量监督检验技术研究院

- ◆ Westinghouse applied the products of this product to the electric heating body of the heater, which increased the heating efficiency of the heater by 40%, solved the pain points of high energy consumption and poor effect of the existing heater, and greatly improved the heating effect and Customer Experience.
- ◆ The cost will increase by about 1,5 €/unit, but the terminal retail price will increase by 35-50 €/unit.

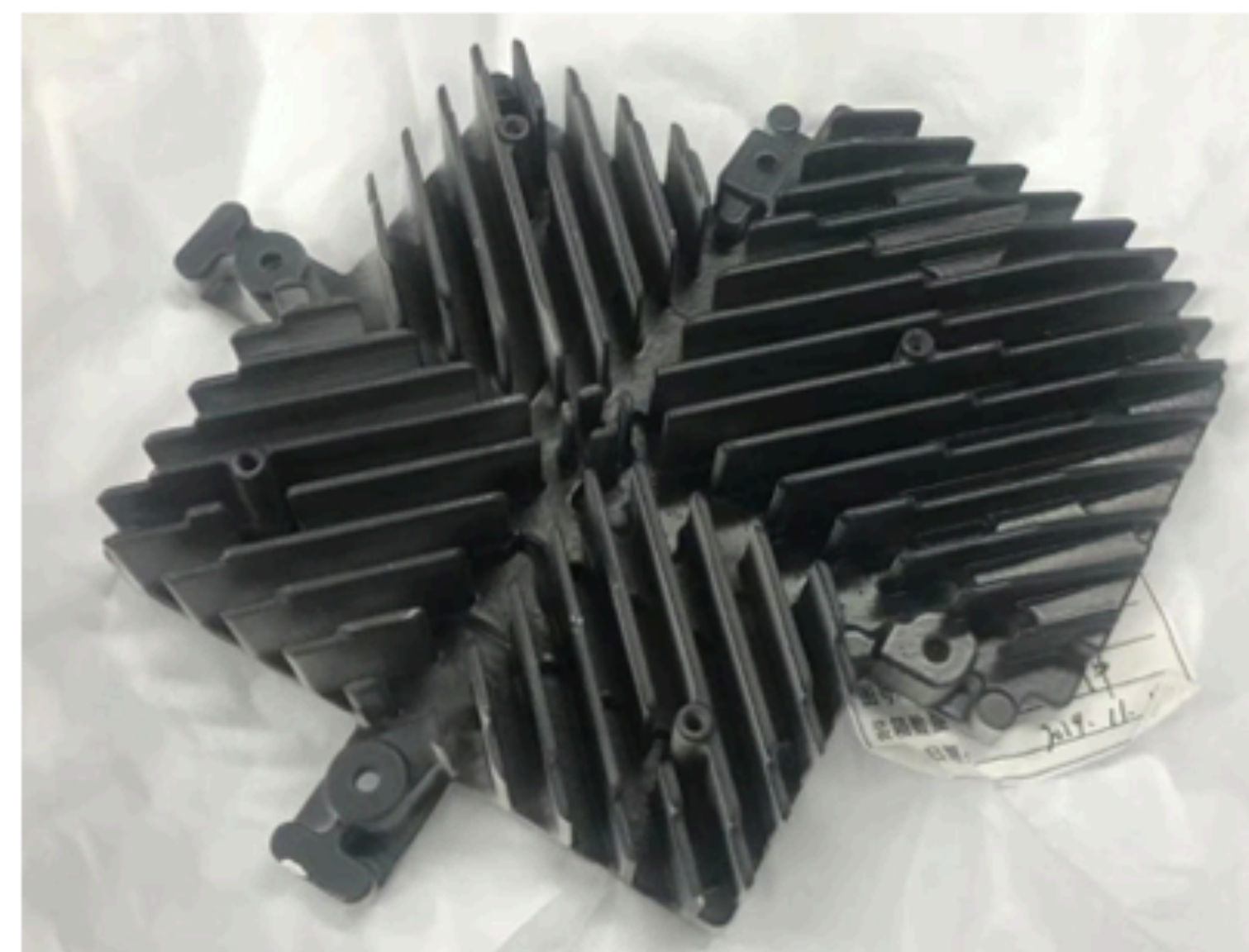
Improve performance + solve rigid demands+ explore market



Graphene coated LED aluminum heat sink

With this product, the weight of the aluminum heat sink of the LED lamp can be reduced by 30%, and the original heat dissipation performance can be maintained and the product cost can be reduced.

**Improve performance
optimize cost**



Graphene-coated board heat sink

Co-developed the application of coatings on 5G base stations with China Mobile Research Institute. Simplify the design of the heat dissipation system, reduce the mechanical heat dissipation structure, and improve the heat dissipation performance and system reliability.

**Improve performance
solve rigid demands**



The graphene heat radiation/heat dissipation paint is sprayed on the inner wall of the heating cavity of industrial tunnel furnaces and high-temperature ovens, and the working efficiency of industrial tunnel furnaces and high-temperature ovens can be greatly optimized by using the heat radiation effect. Shorten heating time, improve temperature uniformity, and reduce energy consumption.



Improve performance
solve rigid demands

	Heating time	Temperature uniformity	Average energy consumption
Before treatment	56 min	±10°C	15KW
After Treatment	25 min	±5°C	12KW
Improvement	Above 50%	50%	Ca. 20%

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13.04.2021

Prüfbericht Nr. / Report No. 0001085325/20 AZ 407754

Gegenstand der Prüfung / Test item: Beschichtungsmaterial/coating compound

Bezeichnung / Identification: SR-100-L

Zustand bei Anlieferung/ Condition at delivery:	Einwandfrei / No claim
--	------------------------

Eingangsdatum / Date of delivery: 26.03.2021

Prüfart / Place of testing: Köln/Cologne

Prüfzeitraum / Test period:	07.04.2021	bis / to	13.04.2021
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Prüfungsbereich / Test scope:	Vom Kunden ausgewählte Parameter Parameters selected by customer
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Prüfgrundlage/ Test specification: RoHS Richtlinie 2011/65/EU
RoHS Directive 2011/65/EU

Prüfgegenstand entspricht den Anforderungen der Prüfgrundlage.
The test item meets the requirements of the test specification.

geprüft von / tested by

genehmigt von / authorized by:

13.04.2021

13.04.2025

X *He m m*

Sachverständiger/Expert
Signiert von: Markus Clemens

X *Ph.*

Sachverständige(r)/Expert
Signiert von: Ralf Meier

Die Prüfergebnisse beinhalten sich ausschließlich auf die untersuchten Proben. Falls bei Bewertungen erfolgen, wenn nicht anders bekannt, ohne Berücksichtigung der Messunsicherheit. Dieser Prüfergebnis auf eine absolute Genauigkeit der Messung zu verlässlichen werden und beinhalten nicht auf die Verwendung der TÜV Rheinland Group Prüfverfahren. / The test results exclusively refer to the samples tested. Except as stated otherwise partial assessments do not consider the uncertainty of measurement. This report shall not be reproduced except in full without written approval and does not authorize the use of a TÜV Rheinland Group label.

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15.04.2021

Prüfbericht Nr. / Report No. 0001085325/10 AZ 407753

Gegenstand der Prüfung / Test item: Beschichtungsmaterial / Coating material

Bezeichnung / Identification: SR-100-L

Zustand bei Anlieferung/ Condition at delivery:	Einwandfrei / No claim
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Eingangsdatum / Date of delivery: 26.03.2021

Prüfart / Place of testing: Köln/Cologne

Prüfzeitraum / Test period: 07.04.2021 bis / to 15.04.2021

Prüfungsbereich / Test scope:	Vom Kunden ausgewählte Parameter Parameters selected by customer
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geprüft von / tested by:

genehmigt von / authorized by:

15.04.2021

X 6. Klausur der Region

Sachverständigenprüfung
Signiert von: Anette Heinrich de Melia

15.04.2021

X F.Es-Saddik

Sachverständige(r)/Experte(r)
 Signiert von: Fatema Is-Saddiki

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