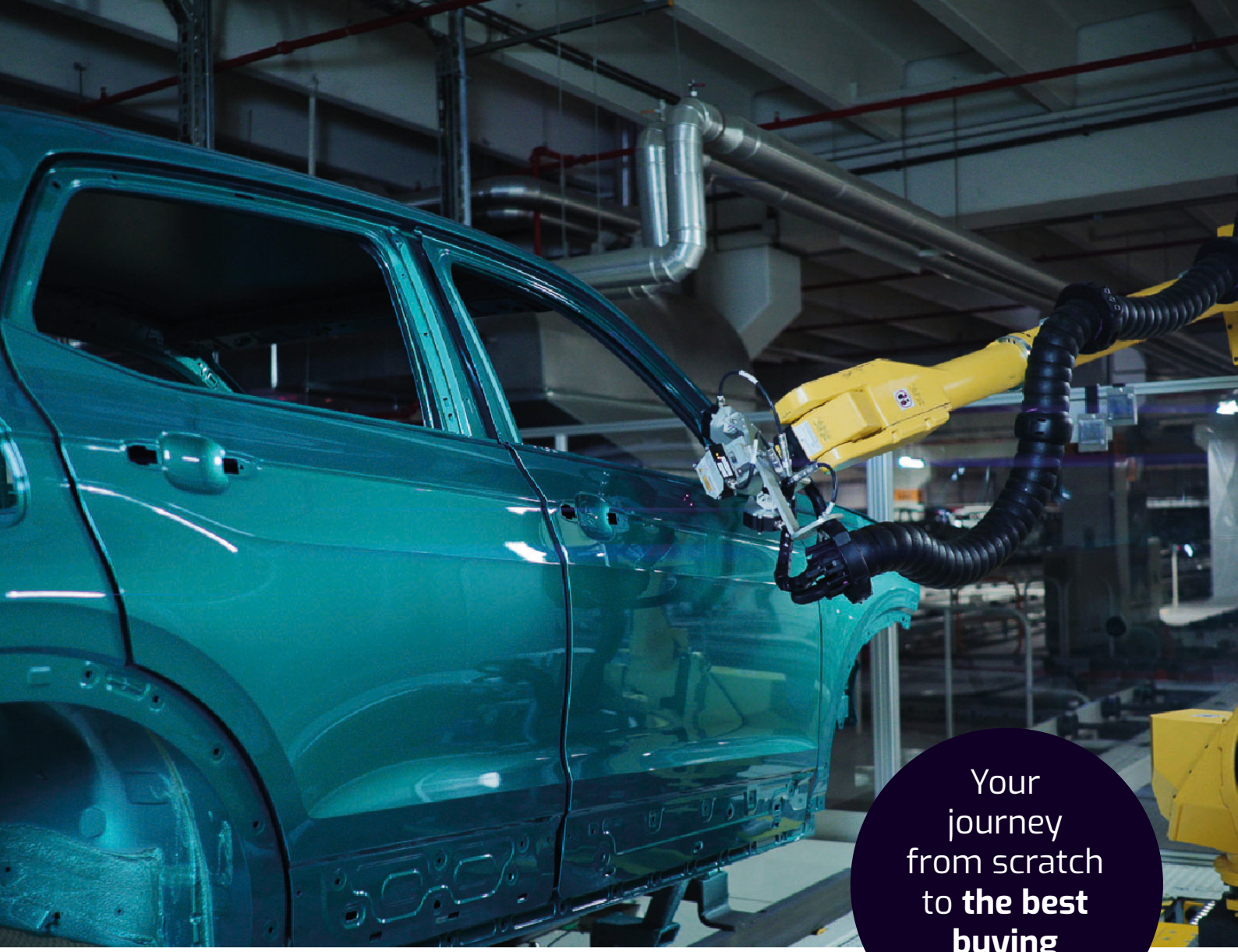


Your journey from scratch to **the best buying decision**

FOR AUTOMOTIVE SECTOR

BUYER´S GUIDE
Coating Thickness Measurement Technologies

Terahertz vs Ultrasounds and others

das-nano

BUYER´S GUIDE
Index of contents

1. Presentation · 4
2. Executive Summary · 5
3. The role of advanced coating thickness measurement in the automotive industry · 7
4. Automotive sector and the coating thickness measurement: a story of pain points · 8
5. Coating thickness measurement techniques: a comparative overview · 10
6. Choosing the right terahertz technology: what to consider to make the best purchase decision · 16
7. Coating thickness terahertz technologies comparison table · 20
8. Buyer's Guide cheat sheet: your RFQ step by step · 30
9. About the author · 44

1. Presentation

Coatings serve as a protective barrier shielding surfaces from environmental damage.

When undertaking a painting project, the key to effectiveness lies in ensuring a high-performance coating. Performance hinges on two critical factors: the paint quality and the coating thickness.

While the common assumption is that thicker coating layers equates to superior protection, this is only sometimes true. Excessive thickness can result in an uneven textured finish and susceptibility to cracking under external forces. When surfaces feature cuts and grooves, opting for a thick coating is counterproductive.

Achieving the optimal balance of protection and aesthetic appeal requires proper coating thickness. Precise control and monitoring of coating thickness are essential to prevent under or over application. This approach ensures a polished surface finish and optimal performance and durability.

The automotive industry places significant importance on regulating the coating layers applied to their vehicles. In this comprehensive Buyer´s Guide, we aim to elucidate all considerations for achieving optimal results in the coating process, utilizing cutting-edge technology to guarantee excellence.

2. Executive summary

Reading this Buyer´s Guide you will receive these main takeaways:

1. **Critical role of coating thickness in automotive excellence**
Understanding the important role coating thickness plays in automotive quality and durability; this guide explores the nuanced dynamics of achieving the optimal balance between protection and aesthetic appeal in the automotive sector.

2. **Technology as a catalyst for efficiency and precision**
Delving into the challenges the automotive industry faces in coating thickness measurement, the guide emphasizes the transformative potential of advanced technologies. These innovations are poised to revolutionize efficiency, precision, and cost-effectiveness in the manufacturing process.

3. **Navigating pain points**
Recognizing the pain points in existing car body coating thickness measurement methods, the guide sheds light on the limitations of traditional approaches. It underscores the need for a paradigm shift toward innovative technologies to address these challenges comprehensively.

4. **Comparative overview of techniques**
Offering a comparative analysis of coating thickness measurement techniques, this guide explores the strengths and limitations of ultrasonic and terahertz methods. It gives manufacturers valuable insights to make informed decisions aligning with their unique production requirements.

5. **Terahertz (THz) technology as the new standard**
The guide highlights terahertz technology as the forefront contender for the future of coating thickness measurement. It accentuates its unparalleled capabilities in achieving contactless measurements, multilayer assessment, automation integration, and compatibility across diverse substrates and type of coatings.

3. The role of advanced coating thickness measurement in the automotive industry

In the ever-evolving landscape of automotive manufacturing, industry leaders aspire to attain optimal performance and competitiveness by prioritizing key objectives.

Achieving these goals necessitates the integration of cutting-edge coating thickness measurement technology, a crucial component in reshaping industry standards.

1. **Cost savings: time, materials & energy**
Efficient resource utilization is a fundamental aspiration for automotive manufacturers. The goal is to save time, materials, and energy costs, ultimately enhancing operational efficiency and financial viability.

2. **Reduction in reworks & wastes**
Minimizing errors and waste in the production process is a central objective for sustainable and economically sound operations. Manufacturers aspire to implement precision technologies that reduce the need for reworks and minimize material wastage.

3. **Elevated quality control standards**
The pursuit of elevated quality control standards remains a constant in the automotive sector. Leading manufacturers seek to implement technologies that provide accurate and real-time data, ensuring that each coating meets the stringent quality standards required for superior automotive finishes, with perfect color matching and avoiding typical problems such as orange peel on the coating, among others.

4. **Agile decision-making with real-time data and analytics**
In the fast-paced automotive industry, agile decision-making is a strategic objective. Manufacturers aspire to harness real-time data and analytics capabilities, empowering them to make informed decisions promptly and stay ahead of industry trends.

5. **Minimization of environmental impact**
Environmental sustainability is a key concern for automotive manufacturers. To minimize the overall environmental impact associated with manufacturing, manufacturers aim to optimize coating processes and reduce waste in alignment with eco-friendly practices.

These aspirations underscore the importance of investing in the best-in-class coating thickness measurement technology. As automotive manufacturers strive to balance efficiency, quality, and sustainability, integrating advanced measurement solutions becomes a key step toward achieving these objectives in the competitive automotive landscape.

4. Automotive sector and the coating thickness measurement: a story of pain points

In the highly competitive automotive sector, maintaining stringent quality control processes is imperative.

The existing global methods for measuring car body coating thickness have proven to be flawed, prompting the need for innovative technology to address these shortcomings.

Significant hurdles encountered in the realm of car body painting control encompass the following critical issues:

Lack of accuracy
Old methods provide thickness accuracy of 10 micrometers in each layer making the methods only good enough for production control in manufacturing processes with large safety margins.

Costly and partial manual processes
Traditional methods involve expensive and partially manual measurement processes, contributing to lack of repeatability, operational inefficiencies, and increased expenses.

Contact systems with potential damage
The reliance on contact systems poses a risk of damaging the car body coating during measurement. What is more concerning is that it may introduce errors in subsequent automated surface defect detection systems due to residual couplant liquids, thereby exponentially increasing false positives, and typically difficult to integrate into the production process since it requires bringing water and air connections to the measurement cell.

Technology limitations on substrates
Many existing technologies are exclusively applicable to metallic substrates, neglecting the need to measure coating thickness on plastic and glass or carbon fiber reinforced components, materials increasingly common in vehicles due to their lightweight and flexibility.

Systems valid only for flat surfaces
Certain measurement systems are designed for flat surfaces, overlooking the intricate and varied contours of modern car bodies. This limitation restricts the applicability of such technologies across the entire vehicle.

To overcome these challenges and enhance the efficiency of quality control processes in car body painting, there is a growing demand for advanced technologies that offer precise, non-destructive, and substrate-agnostic coating thickness measurements. This pursuit of innovation aims to elevate the industry standards and ensure the production of high-quality automotive finishes.


Irys | Analytics Platform

5. Coating thickness measurement techniques: a comparative overview

In the complex realm of film build measurement, manufacturers rely on diverse techniques to ensure precision and quality in their processes. The four primary methods—*Inductive, Ultrasonic, Photothermal, and Terahertz*—bring unique capabilities and considerations.

From the electromagnetic principles of inductive measurements to the sonic accuracy of ultrasonic techniques, the thermal response in laser induced photothermal processes, and the cutting-edge terahertz waves technology, these approaches cater to various substrates, shapes, and automation needs.

This comprehensive overview delves into the intricacies of each method, shedding light on their distinctive features and applications in the ever-evolving landscape of industrial coating processes.

1. Inductive coating thickness measurement
CAUTION > Single-Layer precision with contact dependency in metallic substrates

Ultrasonic coating thickness measurement is pivotal in pursuing precise and versatile industrial quality control.

Leveraging sound waves to determine coating thickness, this method excels in applications where multilayer structures and diverse substrates are commonplace. The sonic accuracy of ultrasonic techniques provides manufacturers with a reliable means of assessing thick coatings. However, the requirement for direct contact poses challenges, mainly when dealing with intricate or delicate surfaces, underscoring the importance of a discerning approach to its application.

Capabilities:	**Suitable for metallic substrates** Inductive measurement excels in assessing the coating thickness in metallic substrates. Its capability to accurately gauge thickness of coatings on various metallic materials makes it a traditionally preferred choice in industries where metals play a crucial role in manufacturing processes.
Limitations:	**Lack of precision in soft coatings** Achieving accurate measurements with inductive technology can be challenging, particularly when dealing with soft coatings. Factors such as the magnetic permeability of the base material and the surface roughness play significant roles in influencing measurement accuracy. Soft coatings tend to deform under the influence of the magnetic field, leading to inconsistencies in measurement results. Therefore, meticulous calibration and consideration of material properties are crucial to mitigate errors and ensure reliable data acquisition.

Limitations:	**Partial information in multilayer structures** Inductive technology faces limitations when assessing coating thickness in multilayer structures. The comparative nature of electromagnetic measuring methods requires calibration adjustments to accommodate varying material compositions within the layers. Without proper calibration and understanding of the magnetic permeability of each layer, measurement accuracy may be compromised, resulting in partial or inaccurate information regarding individual layer thicknesses. Careful consideration of calibration protocols and material characteristics is essential to extract meaningful data from multilayer structures and make informed decisions regarding coating applications.

2. Ultrasonic coating thickness measurement
CAUTION > Moderate precision with contact dependency

Ultrasonic film build measurement is pivotal in pursuing precise and versatile industrial quality control.

Leveraging sound waves to determine coating thickness, this method excels in applications where multilayer structures and diverse substrates are commonplace. The sonic accuracy of ultrasonic techniques provides manufacturers with a reliable mean to assess thick coatings. However, the requirement for direct contact poses challenges, mainly when dealing with intricate or delicate surfaces, underscoring the importance of a discerning approach to its application.

Capabilities:	**Effective for Multilayer Measurement on Various Substrates** Ultrasonic measurement proves highly effective in assessing film build within multilayer structures, offering manufacturers detailed insights into the composition and integrity of complex coatings. Its versatility extends across various substrates, with limitations, making it a valuable tool in industries requiring comprehensive quality control over thick coatings.
Limitations:	**Requires Direct Contact, Limiting Applicability to Curved or Delicate Surfaces** The reliance on direct contact for ultrasonic measurements presents a notable limitation, particularly in scenarios involving curved or delicate surfaces. The need for physical contact may pose challenges in maintaining the integrity of intricate coatings, urging manufacturers to consider alternative methods for achieving accurate measurements in such contexts.
	Ultrasound Coupling Challenges: Potential for False Positives in Thickness Measurement Ultrasound measurements rely on coupling mediums like couplant liquids or compressed air, which can introduce inaccuracies due to difficulty in penetrating small crevices or maintaining consistent contact on irregular surfaces

Taking this into consideration, we can conclude that ultrasonic measurement excels in its accuracy and applicability to multilayer structures with thick coatings, but its limitation on direct contact requires a thoughtful consideration, especially in industries where preserving the integrity of curved or delicate surfaces is a must.

3. Photothermal coating thickness measurement
CAUTION > Illuminating insights with caveats

Photothermal methodology emerges as an innovative and contactless approach in the intricate tapestry of coating thickness measurement techniques. Harnessing the thermal response of materials to laser-induced heating, this method offers a valuable solution for assessing coating thickness on flat surfaces. While its proficiency in contactless measurements is a standout feature, the technology encounters limitations, particularly in handling multilayer structures and contoured surfaces.

Capabilities:	**Suitable for contactless measurement on flat surfaces** Photothermal film build measurement excels in providing accurate assessments without the need for physical contact. This contactless attribute makes it an ideal choice ensuring the preservation of surface integrity during measurements.
Limitations:	**Limited applicability to multilayer structures** Despite its efficacy on flat surfaces, photothermal measurement faces challenges when applied to multilayer structures or when applied to curved surfaces. The technology may encounter limitations in providing detailed insights into the thickness of individual layers within complex coatings, prompting manufacturers to assess its suitability for their specific applications carefully.
	Complex calibration processes The limitations of photothermal technology for measuring layer thickness primarily stem from its reliance on inductive data for calibration and from the necessity to paint at least one car body in a specific manner to carry out such calibration. In addition to programming the paint robots to coat this body according to the requirements of this technique's calibration, it is also necessary to consider the subsequent repainting of the same, as it renders it unusable.

Photothermal measurement shines in its contactless precision on flat surfaces, manufacturers should be mindful of its limitations, especially when dealing with intricate multilayer structures where alternative methods might offer a more comprehensive solution.

4. Terahertz waves technology:
CAUTION > Pioneering the future of coating thickness measurement

Terahertz film build measurement stands at the forefront of innovation, utilizing terahertz waves for precise measurements. This advanced method excels in various aspects, offering contactless measurements, versatility in multilayer structures, automation capabilities, compatibility with curved surfaces, wet paint measurement, and human safety.

Capabilities:

Contactless measurements
Terahertz technology enables contactless measurements, ensuring that delicate surfaces remain undisturbed during the assessment process. This feature is crucial in preventing potential damage to intricate coatings or surfaces susceptible to physical interference. In addition, this technology is completely harmless for humans.

Achieving 1 µm thickness precision
Not all terahertz technologies achieve it, but das-Nano's does: By harnessing the power of terahertz waves, our technology delivers unmatched thickness accuracy, achieving measurements as precise as 1 µm. This exceptional precision enables meticulous control and optimization across diverse industrial applications

Versatility in multilayer structures
The technology exhibits exceptional versatility in accurately measuring coating thickness in multilayer structures. It provides a detailed analysis of individual layers, contributing to enhanced precision in assessing complex coatings commonly found in modern manufacturing.

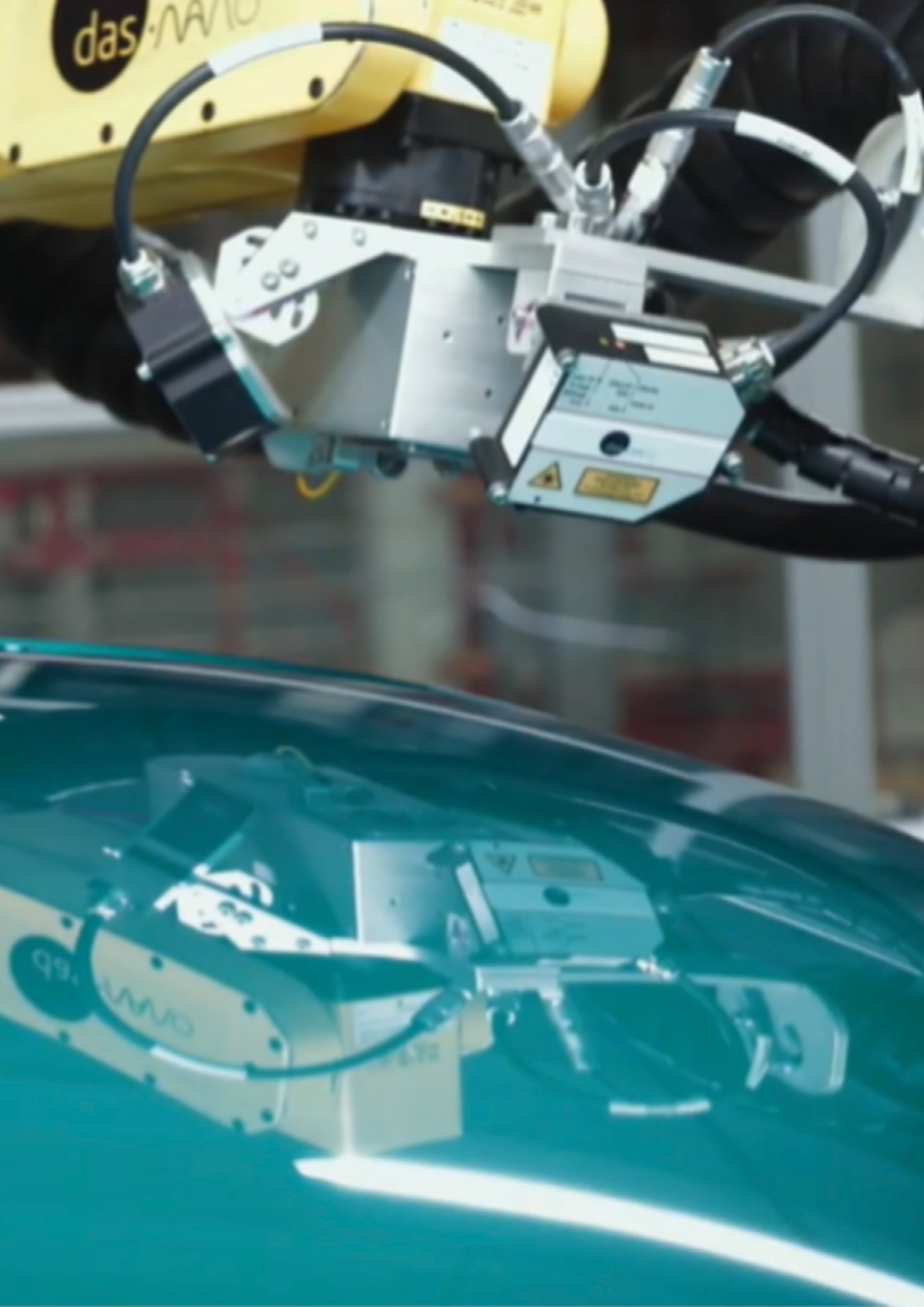
Moreover, terahertz technology excels in measuring on curved surfaces and even over wet or damp coatings, offering unparalleled flexibility in various application scenarios. Additionally, it demonstrates the capability to measure on diverse substrates, including metallic, plastic, and composite substrates, further highlighting its adaptability across a wide range of industrial environments.

Automation capabilities
Terahertz-based methods seamlessly integrate into automated processes, increasing efficiency and reducing manual intervention dependency. This aspect is particularly valuable in modern manufacturing environments where streamlined processes are paramount.

	Additionally, being couplant-free and air-compressed-free, the most advanced terahertz technologies simplifies operation and eliminates the need for additional materials or equipment. Its automation capabilities also make it ideal for integration into data analytics platforms, empowering industries to learn and react swiftly to incidents, thereby enhancing efficiency and productivity.
Limitations:	Emerging technology historically limited in adoption but gaining prominence for its superior capabilities.

As the automotive sector and other industries seek advancements in coating thickness measurement, terahertz-based methods emerge as the superior choice, offering a comprehensive solution that aligns with evolving manufacturing needs.

TECHNOLOGY	Terahertz	Photothermal	Ultrasonic	Inductive
1 Contactless + Non-destructive testing (NDT)	✓	✓	✗	✗
2 Multilayer	✓	✗	✓	✗
3 Thickness accuracy: 1 µm	✓	✗	✗	✗
4 Easily automatable [Couplant free, Compressed air free	✓	✗	✗	✗
5 Metallic, plastic and composite substrates	✓	✗	✗	✗
6 Wet paint	✓	✓	✗	✗
7 Flat and curved surfaces	✓	✓	✗	✗
8 Harmless for humans (non-ionizing)	✓	✗	✓	✓



6. Choosing the right terahertz technology: what to consider to make the best purchase decision

As we already see in the previous chapters of this guide, in the dynamic landscape of industrial manufacturing, where precision and efficiency are key, the selection of coating thickness measurement technology plays an essential role in ensuring product quality and process optimization.

With its advanced capabilities, terahertz waves technology has emerged as a forefront contender for manufacturers seeking accurate, contactless, and versatile solutions.

This section serves as your compass in navigating the options available, providing a comprehensive guide to evaluate and choose the right terahertz waves technology.

As you embark on this journey, essential questions arise: Does the technology align with your needs? Can it seamlessly integrate into existing processes, and does it offer precision to your industry standards?

Here, we delve into key features and considerations, framing essential questions to pose to potential providers. From contactless measurements and multilayer capabilities to automation, compatibility with various substrates, and support services, each aspect is scrutinized to empower you with the insights necessary for an informed purchase decision.

Let's embark on this exploration together as we unravel the intricacies of terahertz technology, guiding you toward a selection that aligns seamlessly with your manufacturing aspirations.

>> In the following table, you will find questions and explanations to help you understand the different characteristics of thickness measurement systems using terahertz waves technology.

>> Proceed to the next chapter to find a table that will assist you in comparing specific das-Nano's technology characteristics with others.

Key feature	Questions to ask your provider	Explanation
Contactless	- Does the technology offer completely contactless measurements?	This ensures that delicate surfaces remain undisturbed during the assessment process, which is crucial for preventing damage to intricate coatings.

Key feature	Questions to ask your provider	Explanation
Non-destructive (NDT)	- Is the technology non-destructive, allowing for repeated measurements without impacting the material?	Non-destructive (NDT) testing is vital for assessing coating thickness without compromising the integrity of the material, enabling ongoing quality control and notably reducing scrap.
Multilayer results: Individual layer thickness and surface map	- Can the technology accurately measure multiple layers, providing a comprehensive thickness map?	The ability to assess multilayer structures and generate detailed thickness maps enhances the technology versatility and utility in complex coating scenarios.
Thickness Accuracy	- What thickness accuracy can be achieved with the technology?	Precision is crucial, and a high level of accuracy ensures reliable and precise measurements, contributing to quality control standards of ± 1 micrometer.
Easily automatable: Couplant free & compressed air free	- Can the technology be easily integrated into automated processes without the need for couplants or compressed air?	Easy automation enhances efficiency, and eliminating couplants and compressed air simplifies the integration process and reduces operational complexities.
Metallic, plastic, and composite substrates	- Is the technology versatile enough to measure coating thickness on metallic, plastic, and composite substrates?	Versatility across different substrates is essential for the technology to cater to diverse manufacturing needs and applications.
Flat and curved surfaces	- Can the technology effectively measure coating thickness on both flat and curved surfaces?	The ability to handle various surface geometries broadens the scope of applications, ensuring suitability for components with intricate shapes without limiting the inspiration of car designers.

Key feature	Questions to ask your provider	Explanation
Harmless for humans (non-ionizing)	- Does terahertz radiation used in the technology comply with safety standards, being non-ionizing and harmless to humans?	Safety is paramount, and it's crucial to highlight that all terahertz waves are harmless to humans, ensuring the well-being of operators during measurements.
Cabling connections longer than 30 meters	- Does the technology support cabling connections longer than 30 meters for flexible setup configurations?	Longer cabling connections provide flexibility in deployment, allowing the technology to be positioned optimally within the manufacturing environment.
Dual head with one supply unit available	- Is a dual-head with one supply unit option available for simultaneous measurements or enhanced efficiency in specific applications?	A dual-head system can increase the technology versatility and utility, especially in scenarios where simultaneous measurements are advantageous.
Compatible with any industrial robot	- Is the technology compatible with any conventional robot, facilitating seamless integration into existing robotic systems?	Compatibility with standard robots streamlines integration processes, reducing the need for specialized equipment and enhancing overall system flexibility.
IP54 robot head for harsh environments	- Is the robot head equipped with an IP54 rating, ensuring protection in harsh environmental conditions?	An IP54 rating indicates resistance to dust and water, making the technology suitable for deployment in challenging industrial environments with varying conditions.
Car body Temperature: From 10°C (50°F) to 150°C (302°F)	- Can the technology measure coating thickness across a wide temperature range, specifically suitable for car body applications?	The ability to operate within a broad temperature range enhances applicability, ensuring reliable measurements in automotive manufacturing scenarios.

Key feature	Questions to ask your provider	Explanation
Dry, wet, and cured paints	- Is the technology capable of measuring coating thickness on surfaces with dry, wet, and cured paints?	Versatility in handling different paint conditions allows the technology to adapt to various stages of the manufacturing process, contributing to real-time quality control.
Automatable & accurate positioning system	- Can the technology be easily automated, and does it feature an accurate positioning system for precise measurements?	Automation coupled with an accurate positioning system contributes to streamlined processes and ensures precise measurements, critical for maintaining quality standards.
Support service	- What level of support services does the provider offer, including technical assistance and troubleshooting?	A comprehensive support service ensures that any technical issues or queries can be promptly addressed, minimizing downtime and optimizing system performance.
Analytics platform	- Is there an analytics platform available to analyze and interpret the collected data, providing actionable insights?	The existence of a friendly analytics platform enhances the value of the technology by offering tools for data analysis and visualization contributing to informed decision-making and process optimization.
In production with different OEMs	- Is the technology currently in production for several years with various Original Equipment Manufacturers (OEMs) in the automotive sector?	Adoption by multiple OEMs is a testament to the technology reliability and effectiveness, instilling confidence in its performance and suitability for diverse manufacturing environments.

This structured set of questions and explanations aims to guide potential buyers in making informed decisions when evaluating terahertz waves coating thickness measurement technologies.

7. Coating thickness terahertz technologies comparison table

In our commitment to transparency and empowering our clients with comprehensive information, we present a performance benchmark section that allows you to assess and compare our cutting-edge thickness measurement technology with other providers in the industry.

This comparative analysis focuses on key performance indicators across various crucial aspects of our technology. We've also included another column to enable you to fill in corresponding data from another technology provider offering similar solutions.

This hands-on approach aims to provide a holistic understanding of the capabilities, ensuring you make an informed decision aligning with your specific requirements. Explore the table below to delve into the performance metrics that matter most to your operations.

>> For your convenience, we provide a complementary tool that offers the same comparison table in Excel format, allowing you to conduct a thorough assessment with multiple technology providers. If you haven't received this tool with the guide, feel free to request it by emailing your contact in our company website www.das-nano.com or at info@das-nano.com

Technical feature	**das-Nano**	**Other Providers** *Complete with supplier information*
PERFORMANCE OF THE SYSTEM		
Contactless	YES - Optimum working distance to inspected surface: 100 mm. Other distances are possible.	
Non-destructive (NDT)	YES - Our positioning sensors and terahertz waves are harmless to the surface.	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
Thickness accuracy	± 1µm - Accuracy verified following the Gold Standard (micrography).	
Multilayer & multilayer thickness map	YES - Up to 7 layers - We provide a complete infographic map of your car body surface. - Sampled area per point: 4 mm. spot size.	
Measurement time per point	- Between 0.5 and 5 seconds. This time includes movement of the robot to the measurement point, normal positioning to the surface and measurement.	
Position accuracy of the robot head	Normal incidence to the inspected surface error < 0.2º	
Harmless for humans (Non-ionizing)	YES	
MEASURABLE COATING CONFIGURATIONS		
Able to measure on STEEL substrates	YES - Including galvanized or electro-galvanized.	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
Able to measure on ALUMINUM substrates	YES - Including anodized aluminium.	
Able to measure on PLASTIC substrates	YES - Thermoplastic - Elastomers - ...	
Able to measure on COMPOSITES substrates	YES	
Able to measure on GLASS FIBER substrates	YES	
Able to measure on CARBON FIBER substrates	YES - Demonstrated up to 7 layers in a OEM. *Read more here*	
Able to measure on MULTILAYERED substrates	YES	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
Able to measure on FLAT and CURVED Surfaces	YES - Curved surfaces, both concave and convex, with bend radio greater than 100 mm.	
Able to measure on DRY paint surfaces	YES	
Able to measure on WET paint surfaces	YES - Moreover, it is possible to predict dry thickness by measuring in wet conditions.	
Able to measure on CURED paint surfaces	YES	
Measureable CLEAR COAT types	Matt, gloss and tinted	
Measureable BASE COAT types	Solid, metallic, pearlescent, two-phase, trilayer and paints with magnetic particles, among others.	

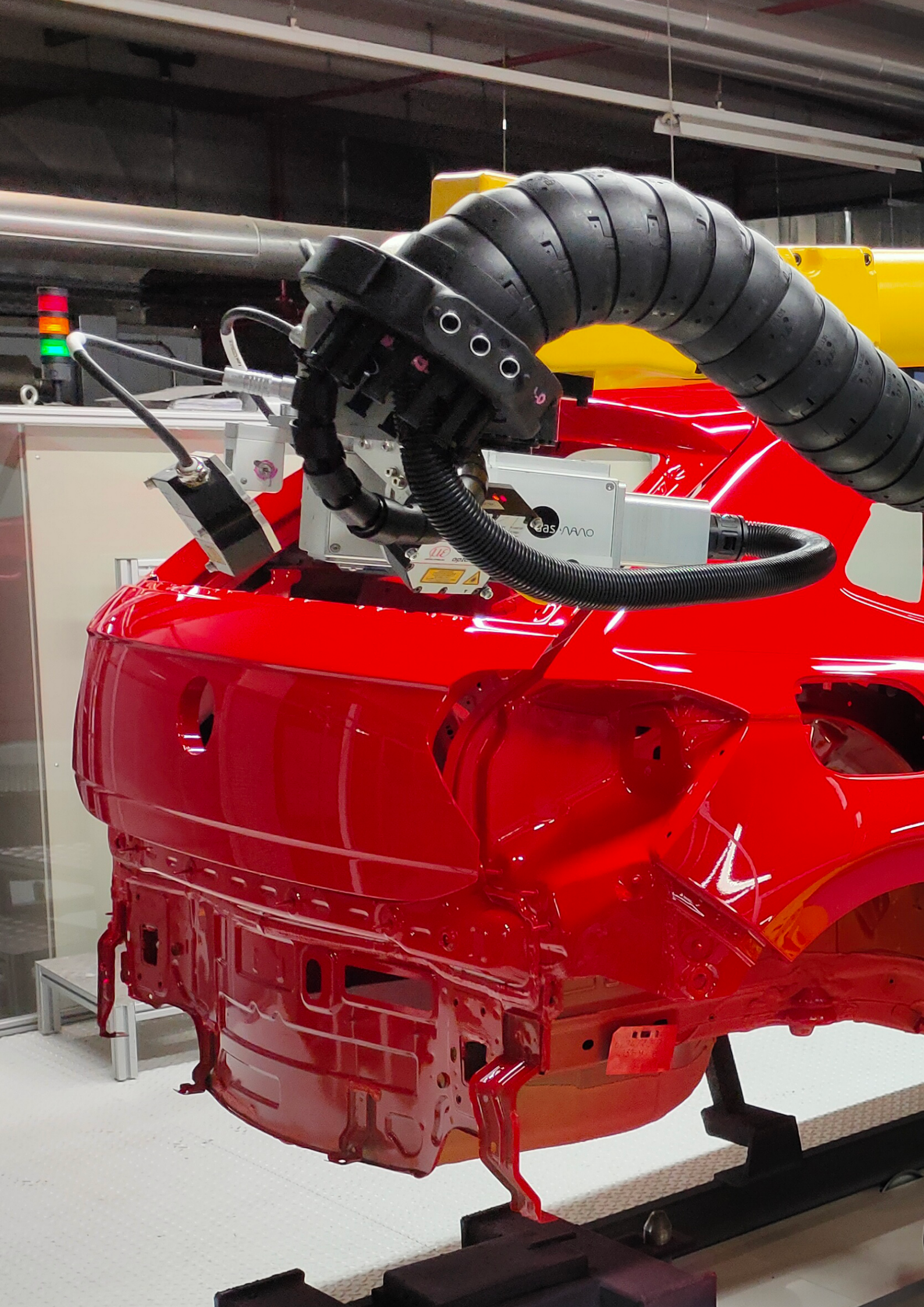
Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
Couplant Free	YES	
Compressed air free	YES	
HARDWARE AND CONNECTIVITY		
Cabling connections longer than 30 meters	YES - Standard solution: 30 m, other lengths are also available.	
Cable sections	YES - Standard solution with two cable sections to facilitate cell maintenance. Option to increase the number of sections.	
OPERATIONAL REQUIREMENTS		
Dual head system available	YES - Possibility of connecting 2 heads to the same supply unit.	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
IP54 robot head for harsh environments	YES - The head has been designed and tested to withstand harsh working environments in factories. It features dust protection to prevent the entry of an amount that could interfere with the proper operation of the equipment and protection against water jets.	
Robot compatibility	YES - Compatible with any conventional robot: any model and brand.	
Operation modes	YES - Automatic mode - Automatic operation with manual entry - Simulation mode (Ghost) - Cleaning operation - Tech/manual mode - Hardware switch - Running empty - Stand-by	
Co-Bot option available	YES - Designed for easy mobility within the manufacturing plant or as a helpful tool in the laboratory. - Measurement head mounted on a collaborative robotic arm and a wheeled structure that allows for easy movement. - Full measuring power of our technology mounted on a portable stand.	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
Operating temperature	Environment: - 15ºC (59ºF) - 35º C (95ºF) - Relative humidity < 75% - Non-condensing atmosphere Car body-part to measure: - 10ºC (50ºF) to 150ºC (302ºF)	
Illumination conditions for operation	No requirements needed; capable of working without light: dark factory.	
Voltage and current requirements	110/240 VAC, 4 A-line power, 50-60 Hz Single phase, two-wire plug.	
Automatable & accurate positioning system	YES - Positioning system designed and patented by das-Nano to ensure maximum perpendicularity and thus calculate thicknesses with the highest precision.	
Vibration compensation system	YES - Patented vibration compensation system that allows working in the presence of vibrations without affecting the thickness measurement results.	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
ADDITIONAL SERVICES AVAILABLES		
Support service	YES - 24/7 assistance - Maintenance plans - Warranty extensions - Technical support (on site & on line) - With our in-house technical support and the collaboration of trusted companies in close proximity to your facility. - Search for new layer schemes - Adaptation of complementary software - Preventive verification	
Analytics platform	YES - Business intelligence dashboard - Production summary - Study of coating thickness evolution - Automated periodic reports - Data export capability - Overview of body thickness - Custom alerts and notifications	

Technical feature	das-Nano	**Other Providers** *Complete with supplier information*
COMPANY KEY DATA		
Made in...	EUROPE	
In production with different OEMs	YES - Our terahertz waves coating thickness measurement facilities dominate, since 2012, the global market, representing 85% of all installations.	
Hours of operability	> 100.000 hours - In industrial installations at OEMs across Europe, China, and North America.	
Capacity / Disponibility	99%	
Patented technology	YES 21 patents in the frame of 11 patent families By topic: - THz core tech: 14% - THz applications: 55% By region: - Europe: 67% - Asia: 19% - America: 14%	



8. Buyer's Guide cheat sheet: your RFQ step by step

In this section, we provide valuable insights into the process of crafting a comprehensive Request for Quotation (RFQ) for coating thickness measurement technologies.

An RFQ is a crucial document that outlines your specific requirements and expectations from potential technology providers. Crafting a well-structured RFQ ensures you receive accurate and tailored quotations, allowing you to make informed decisions when selecting the optimal solution for your industrial needs.

Follow our guidelines to articulate your needs effectively, paving the way for a seamless procurement process and successful integration of advanced coating thickness measurement technology into your operations.

Each section is carefully explained to guide you in articulating your specific needs and expectations. A thorough RFQ also facilitates accurate quotations and ensures that technology providers fully understand the requirements for coating thickness measurement solutions.

Index and template examples for the writing of an RFQ coating thickness measurement technology

INDEX

- Abbreviations
- Project description
- Scope of supply - Measuring cell
- Scope of supply - General
- Schedule
- Operational requirements
- Technical specifications
- Interfaces
- Documentation
- Delivery instructions
- Terms of delivery
- Commercial conditions
- Options
    - Programming of another body type
    - Calibration of another color
- Appendix

Abbreviations **Provide the list of abbreviations used in the document.**

Example:	BC	Base coat
	CAD	Computer aided design
	CC	Clear coat
	KTL	Cathodic dip painting; also known as e-coating (in German: Kathodische Tauch Lackierung)
	PHG	Programmable hand guidance
	PLC	Programmable logic controller
	OPC	OLE (Object linking embedding) for process control
	TCP/IP	Transmission control protocol/Internet protocol
	PR	Primer
	SOP	Start of production
	TBD	To be defined
	THz	Terahertz
	VISU	Visualization
	VZL/PR	Pre-primer/Primer
	[TERM]	[DESCRIPTION]

Project description

A brief scope of work that should include at least the following key data:

- Basic scope
- Location of the manufacturing plant
- Type of measurement cell
- Quantity of measured car bodies
- Number of robots
- Project language
- Notes and reference documents

Example:
Option A) A new paint shop is being constructed at [NAME OF THE MANUFACTURING PLANT] manufacturing plant in [LOCATION: CITY (COUNTRY)]. Option B) The pain shop of [NAME OF THE MANUFACTURING PLANT] in [LOCATION: CITY (COUNTRY)] will undergo modifications.

This document outlines the scope of the required delivery to install an automatic [OFFLINE/INLINE] thickness measurement cell. The basic objective of the cell is to measure the thickness of each paint layer on the car bodies, of at least [NUMBER] % of the produced bodies.

To achieve this, [NUMBER] robots must be installed, [NUMBER] for each side to measure layer thickness.

The project language is [LANGUAGE].

The CONTRACTOR must consider all the information contained in this document along with the information provided in the general guidelines of the group (see the list of the referenced documents in the Appendix). If, after analyzing the documentation, there is anything that doesn't fit, it is the responsibility of the CONTRACTOR to offer everything necessary to ensure the correct operation of the cell from a quality, availability, quantity, and safety standpoint.

Scope of supply - Measuring cell

Provide a comprehensive list and detailed description of the components and services of the measuring cell that the CLIENT expects to be included in the package. This ensures clarity on what is being requested.

Example:

The scope of work of the measuring cell is briefly introduced in the following table and further described below.

Component	Number	Manufacturer	Spare components	Comments
Security fence	1	TBD	-	
Robot	2	TBD	Brakes	
Travel or 7th Axis	2	TBD	-	
PLC	2	SIEMENS	1	
VISU	1	TBD	-	
Electrical and control technology	1	TBD	-	

Component	Number	Manufacturer	Spare components	Comments
Terahertz thickness measurement technology	1	das-Nano	1x Cabling package 1 x Robot head	It includes everything necessary for thickness measurement., i.e. 2 robot heads, 1 supply unit, cabling package...
Analytics platform	1	das-Nano	-	
Manufacturer-specific tool kits for assembling and disassembling the robot(s)	1	TBD	-	
Manufacturer-specific tool kits for maintenance of the terahertz system	1	das-Nano	-	

The entire measuring cell must be surrounded by the safety fence. The fence must be made of transparent material such as plastic or glass and must incorporate safety features for access doors, as well as for the robots entering and exiting the cell on the conveyor. The fence should be designed for easy and quick opening during repair or maintenance tasks.
The CONTRACTOR needs to carefully review the specified scope of supply configuration. If the CONTRACTOR believes that additional robots are required to measure all points within the necessary cycle time, this should be clearly mentioned in the offer. Furthermore, an optimized version should be proposed as an optional addition. However, the scope outlined here should always be offered as the foundation.
When delivering the system technology, it's important to ensure a consistent inventory of spare parts. A component/spare parts list should be generated prior to production commencement and presented to the CLIENT for examination. This list should detail the installation location, manufacturer, type, and estimated delivery time for each component.
The use of materials containing silicone, coated with silicone, or interfering with leak wetting is not allowed.
The warehouse size must ensure that the functionality of the systems in this module is not compromised due to the absence of spare or worn parts on-site. A relevant order/stock list should be provided to the CLIENT during project discussions.

Scope of supply - General

Provide a comprehensive list and detailed description of the general components and services (excluding the specific ones of the measuring cell) that the CLIENT expects to be included in the package. This ensures clarity on what is being requested.

Example:

The general scope of supply includes the following elements:

- Technical coordination of the installation and start-up of the measuring cell.
- Layout of the measuring cell with the representation of the interfaces. A CAD data file must be delivered to the CLIENT after the project has been completed.
- Construction of assemblies.
- Construction of the measuring cell.
- Calculation and design of system parts.
- Creation and coordination of schedules with the CLIENT.
- Compliance with quality specifications by the CLIENT'S process department.
- Procurement of all required materials.
- Pre-assembly of sample assemblies. It must be completed at least [NUMBER] months before the planned shipping date of the system components. The whole measuring cell with the measuring, conveyor and safety technologies must be set up and put into operation.
- Pre-acceptance of sample assemblies with the CLIENT.
- Implementation of change requests to the CLIENT.
- Production of the remaining assemblies.
- Installation of the entire system according to flow technology aspects (low dead space, easy emptying / pigging of the pipelines, etc.) on the construction site.
- Compliance with legal or other requirements regarding the technical equipment of the installation (e.g. fire protection, explosion protection...).
- Test of system components: switching on and off, process sequence with conveyor technology, movement programs of the robots, starting up after malfunctions, thickness measurement, visualization and operation, etc.
- Creation of relevant documents.
- Carrying out the cleaning/rinsing of system parts (disposal of the rinsing media by the CLIENT).
- Obtaining operating approval from institutions (e.g. TÜV, local authorities).
- Commissioning of system components together with the CLIENT.

Detailed training schedule for new systems, divided into two packages: operator and maintenance team training and briefing. It includes 6x days of training and 6x days for briefing in the offer, with an optional price for additional training days. Training and briefing will not occur continuously.

- Training on the use of the analytics platform and evaluation of the results.
- Simulation of the system configuration for its verification. The simulation is cost-neutral for the CLIENT and can be requested after the order has been placed.
- Machine capability studies (MFU) and process capability studies (PFU) for [NUMBER]% of the total capacity of a shift and/or for at least [NUMBER] hours/shift at [NUMBER]%, with the data regarding to positioning accuracy of the robots and reproducibility and compliance with the tolerance of the various measurements (layer thickness, temperature, humidity...). The scope of delivery includes all the equipment required to carry out the MFU/PFU as well as carrying out the test itself.
- Confirmation by the provider of the accessibility and measurability of the number of body types and colors within the specified cycle time specified in section Operational requirements. All systems and parts must be designed and installed in such a way that optimum measurement quality is achieved and that all surfaces are automatically measured at every point on all body types. The supplier receives the CAD data for the car bodies after the order has been placed.
- Material and software supplies for the interfaces.
- Lighting of the measuring cell must be entirely LED.
- Personal protection. The systems must be equipped to immediately halt movement if anyone enters the area during operation. All safety measures must comply with current [EU/USA/China] regulations regarding personal protection. The working and safety zones of the measuring robots must be clearly defined by the dimensions of the housing. The CONTRACTOR is responsible for ensuring that the robots do not pose a risk to individuals in adjacent work areas. Necessary safety components must always be installed within the designated measurement cell area. An emergency stop button must be installed on each control panel and within the switch cabinet group. It must be ensured that in the event of an emergency stop, the robots decelerate as much as possible and the system power supply is cut off.
- Fire protection. In case of a fire alarm, the energy supply must be interrupted and the robots must brake as fast as possible.

Schedule

Provide a comprehensive list and detailed description of the general components and services (excluding the specific ones of the measuring cell) that the CLIENT expects to be included in the package. This ensures clarity on what is being requested.

Example:

The implementation and delivery of the technology should be accomplished according to the following dates:

· Order confirmation: [DATE]
· Installation scheduled: [DATE]
· Commissioning planned: [DATE]

· Training sessions: [DATE]
· Acceptance: [DATE]

Upon placing an order, a detailed schedule will be provided, outlining the installation, commissioning, training and acceptance phases. Any potential delays in system commissioning, arising from construction progress, force majeure, or other unforeseen circumstances, will be communicated well in advance.

Commissioning activities are scheduled to occur during standard working hours (Mon-Sun), with the flexibility to conduct training sessions during night shifts if necessary. The proposal should address any challenges associated with adhering to the proposed schedule.

Operational requirements

Provide quantifiable data of the operational requirements of the measuring cell, as precise as possible.

Example:

The following operational requirements must be considered:

- The measuring cell works autonomously with its own control and visualization.
- Painting process name: [NAME OF THE PAINTING PROCESS].
- Car bodies production: [NUMBER] car bodies per hour.
- Climate conditions of the cell:
    - Temperature > [NUMBER] ºC and < [NUMBER] ºC
    - Relative humidity > [NUMBER] % and < [NUMBER] %
- Temperature of the car body at each measurement point and relative humidity of the measuring cell must be measured.
- Initial number of calibrated colors: [NUMBER] colors. Extra calibrations are optional and described in section OPTIONS.
- Initial number of programmed body types: [NUMBER] body types. It must be possible to manage up to [NUMBER] body types. The 3D data of the initial body types will be given to the CONTRACTOR by the CLIENT after the order confirmation.
- Measurement data must include the following info:
    - Date and time
    - Body ID
    - Body type/model
    - Color/color code
    - Painting line ID
    - Measurement point area
    - Measurement point ID
    - Thickness of each layer
    - Temperature of the measurement point surface at the measurement time
    - Measuring cell relative humidity
    - [OTHER DATA]

- The definition of the measurement areas will be [given by/agreed with] the CLIENT.
- Measurement point numbers must be identified for each side of the body, eg. L10 and R10, for the tenth left and right points, respectively. Measurement point distribution of each side of the body should be mirrored images.
- The thickness of each layer must be measured over at least [NUMBER] % of the car body production. Every car body must be inspected in [NUMBER] points. Therefore, the maximum measuring cycle time (measuring time for each car body) is [NUMBER] s.
- High runner colors should be checked at least [NUMBER] times per shift, while low runners should be checked at least [TIME PERIOD].
- The thickness values in the following table correspond to the acceptable ranges in the painting line.

Layer	Target thickness (µm)	Minimum thickness (µm)	Maximum thickness (µm)
KTL/E-COAT			
VZL/PRIMER			
BC			
CC			

- The contractor bears no responsibility for measurements taken inside the vehicle, which include:
    - Hood interior
    - Engine compartment
    - Door jambs
    - B-Pillars
- The correct functioning of the thickness measurement system is regularly controlled every [TIME PERIOD or EVENT, SUCH AS ENTRANCE OF A CAR BODY], by measuring a table with calibration samples. The thickness results are compared with the stored data and an alarm is played on the VISU in case of a thickness difference bigger than [NUMBER] µm. The CONTRACTOR must include in the offer a description of this control process.
- If the quality specifications cannot be achieved due to parameters that are not within the CONTRACTOR'S control (e.g. sheet metal quality, KTL quality, paint quality, etc.), the responsibility does not lie with the CONTRACTOR.
- A Programmable Hand Guidance (PHG) has to be supplied for each robot. Its menu navigation should be at least in the project language and in the national language.
- All robots can be programmed completely online and offline using the handheld programming device. The calibration of robots must be logged and handed over to the CLIENT. The software and hardware must allow to adjust the robot position after a repair or other circumns-

tances; for it, it should be installed at least two mechanical reference points in the measuring cell for each robot that forces the robot to move all axes from the home position to reach each reference point and check if the axis position is correct.
- Every robot has, at least, 6 axes, with its own brakes and end stops. The robot supply lines must be routed to the outside via the shortest possible route. The load-bearing capacity must be enough for all the measuring devices (i.e. thickness measurements and optional sensors). The robot maximum movement speed must be at least [NUMBER] mm/s, regardless of the body contour. For robots without permanent lubrication, an automatic lubrication system must be included in the system and any faults or lubrication intervals must be displayed on the visualization. The measuring head that contains the terahertz head and other optional sensors must be mounted in the smartest way to favor its changes in the shortest time.
- The 7th axis/axes should be offered as a floor axis.
- It is necessary to have a steel walkway with access stairs at the height of the conveyor. The necessary gaps of the walkway should be a maximum of 5 cm wide for reasons of safety. The average inaccuracy of the conveyor should not be greater than [NUMBER] mm in the traversing axes and parallelism should be lower than [NUMBER]º for a maximum length of [NUMBER] m. The average distance to the center of the body should be in the range of ±[NUMBER] mm. The conveyor supply lines must be routed to the outside via the shortest possible route.
The scope of delivery includes a portable lifting and removal device (complete with declaration of conformity and documentation) for dismantling/reassembling (repairing) the robot axes.
- Robots and 7th axes must be able to move simultaneously during the conveying in or out of a car body. All the movements of robots and 7th axes must be done without damaging the car bodies surfaces, either any other element of the measuring cell.
- The CONTRACTOR must deliver proofs of stability of the robots and 7th axes, describing the load introduction and distribution of substructures and suspensions for transport, assembly and installation. Load plans must be delivered to the CLIENT prior to design and manufacture. No additional measures should be necessary to maintain the stability of the building.
- The measuring cell is situated on a [MATERIAL; eg. CONCRETE] floor. Prior to presenting a proposal, the contractor verifies whether the floor can withstand the static and dynamic forces exerted by the robots. Any required measures to distribute weight and reinforce the floor are encompassed within the CONTRACTOR's scope of delivery. Additionally, any necessary steel structures to support traversing axes are also part of the CONTRACTOR's scope of delivery.
- VISU must be placed outside of the measuring cell.
- At the measuring cell, operators should have the capability to manually initiate control measurements for all devices through the VISU.
- It should be able to define warning and limit values using the VISU. When the warning value is reached, the application continues running without interruption, but a warning message is displayed on the visualization interface. This warning message must clearly identify the

measuring device and the process variable involved. If a limit value is surpassed, a corresponding, clear error message will be displayed on the visualization interface.
- The measured thickness of each layer must be documented for every body and it should be accessible at any given time in a database. Additionally, this data must be transmitted to the control center.
- An unlimited license of the programming software used by the CONTRACTOR must be delivered per cell, including all the add-ons. Besides, a full license for work outside of the measuring cell (e.g. offline station) is part of the scope of delivery.
- The complete measuring cell (including a color change block diagram) should be visually represented within this system diagram, including the body type and color, operation status and faults.
- The measurement cell can be operated at least in these operational modes:
    - Automatic: The system operates entirely automatically without requiring any manual data input, whereby type and color information is read or transmitted beforehand. Automatic mode is initiated by pressing a button, while personal protection measures remain active. The ventilation system operates in normal mode (recirculating air).
    - Automatic operation with manual entry: The vehicle halts prior to entering the measuring cell, and the operator is prompted via the visualization system to input relevant data or confirm existing data. Only after this data has been entered does the vehicle proceed into the measuring cell. Activation of this mode requires pressing a button, while personal protection measures remain active. The ventilation system operates under normal conditions.
    - Cleaning operation: In this operational mode, individual robots can be moved to specific positions. The travel speeds must be lowered sufficiently to eliminate any risk to individuals. Following the completion of cleaning/maintenance tasks, the robots return to their home position individually. Activation of this mode requires a given key switch and a button; personal protection measures are overridden. For systems without clocking, the Fault Tolerance (FT) operation continues, the entry light barrier remains active, and is not bypassed by the muting function of the initiators. Access to the cell is possible via the exit.
    - Manual mode: In this mode of operation, the robots are capable of manual movement. Given that programmers frequently need to work in close proximity to the robots or the body, the robots are restricted to a reduced speed that ensures operator safety. Machine movement can be controlled through the system visualization or via a PHG. Activation of this operating mode requires a given key switch and a button; personal protection measures are overridden.
    - Manual mode: In this mode of operation, the robots are capable of manual movement. Given that programmers frequently need to work in close proximity to the robots or the body, the robots are restricted to a reduced speed that ensures operator safety. Machine movement can be controlled through the system visualization or via a PHG.

Activation of this operating mode requires a given key switch and a button; personal protection measures are overridden.
- Hardware switch: The system crucial functions are controlled through discrete hardware components and key switches, such as emergency stop, maintenance switch, station start, operating modes, conveyors, unprocessed bodies, conveyor technology bypass, access protection, and individual robot selection/deselection. The specific number of these components is determined during design discussions and does not incur additional costs.
- Offline: If there is a failure in the measuring system or other components of the system, the entire measuring station must be deactivated. The intake of car bodies must cease. This operational status should be automatically communicated to the higher-level control center. Offline operation can be enabled or disabled using hardware switches.

Technical specifications

Provide quantifiable data of the technical requirements of the measuring cell, as precise as possible.

Example:

The following technical specifications of the thickness measuring cell must be considered:

- Thickness measurement technology: terahertz (THz) technology.
- Approved terahertz technology provider: [NAME OF THE COMPANY].
- Thickness measurement accuracy: ± 1 micron.
- Supplement to the thickness measurement technology: vibration compensation system. The CONTRACTOR must detail its solution in the offer or explain why it's unnecessary.
- The thickness of every layer must be measured simultaneously and recorded separately, regardless of the nature of the layer (eg., metallic paints, matt or tinted varnishes, etc.).
- Analytics platform:
    - The thickness data must be stored in a database. This database can be located on an on-premise server or in the cloud.
    - The analytics platform should not only show the measured thickness values of each layer in each point of each body car, but it should also show the correctness of each thickness values according to the table of layer thicknesses. Values will be differently highlighted (with different colors, for example) if they are higher than the maximum thickness, lower than the minimum thickness or if they are within the accepted thickness range.
    - If there is a series of thickness values out of range, an alarm should be generated.
    - The platform should allow you to create customized visualizations for the representation of selected data.
    - Specific training of the analytics platform should be given to the CLIENT.

Interfaces

Describe the essential interfaces required for seamless integration and optimal functionality.

Example:

The CONTRACTOR is responsible for the correct functioning of the interfaces between the modules for the optimal and safe functioning of the measuring cell. The interfaces should:
- Comply with applicable legal and technical requirements.
- Have the minimal energy consumption and be durable, and therefore, minimize its environmental impact.
- Be easy to use and maintain.
- Have been designed to be adaptable to future modifications of the measuring cell.

At least, the following functions of the interfaces must be taken into account:
- Interface to the [OEM NAME AND PLACE] manufacturing plant IT. The interface should facilitate the layer thickness measurement data to IT.
- Interface to the adjacent modules of the thickness measuring cell to provide the necessary signals and to control the status of all system components.
- Media connections and interface to infrastructure.
    - Material-carrying lines for deionized water, compressed air, etc. should be avoided. If, in the CONTRACTOR's opinion, these lines are necessary, this must be explicitly stated in the offer and an alternative version must be offered as an OPTION.
    Openings in walls and/or ceiling should be detailed in the offer.
    - The measuring cell should have its own consumption meters (for electricity, compressed air, deionized water, etc.) and deliver the data to a given interface of the measuring cell.
    - All cables and media lines within the measuring cell must generally be protected against dirt and must be routed out of the measuring cell area via the direct/shortest route.
    - The measurement system is required to communicate with the main PLC of the cell, model [NAME OF MODEL]. The CONTRACTOR will supply the electrical power (230V/400V), network, and Profinet connection
    - The preferred communication is Profinet, but alternative options (e.g., OPC or TCP/IP) should be described if Profinet is not feasible. Internal connections are the responsibility of the measurement system supplier.
- Interface to the external car body conveyor to exchange, at least, information about the body ID, body tracking, position and release for the conveying in or out of a body.

Documentation

Specify the type of documentation required, including formats and any industry-specific standards that should be adhered to.

Example:
The documentation to be delivered must adhere to the group's standards and what is described in the document [DOCUMENT].

Delivery instructions

Provide clear instructions and preferences for the delivery of the technology, including shipping methods and any handling requirements.

Example:
For reasons of economy and to achieve a short assembly time, the systems must be designed in such a way that the largest possible pre-assembled units can be delivered to the assembly site.

Terms of delivery

Clearly outline the conditions governing the delivery process, including any specific terms or expectations.

Example:
If feasible, special transports should be minimized.

Commercial conditions

Detail pricing considerations, payment terms, and any other commercial aspects that should be taken into account.

Example:
The payment conditions are defined as follows: 1. 50% Down payment at the contract sign. 2. 30% At the delivery. 3. 15% At the commissioning end. 4. 5% At the final acceptance.

Options

Detail the technical specifications of possible options.

Example:

Programming of another body type

The programming of layer thickness measurement for another body type with [NUMBER] colors and [NUMBER] measuring points is not included in the scope of supply and must be offered as an option.

Calibration of another color

The layer thickness calibration of another color for a body type is not included in the scope of supply and must be offered as an option.

Appendix

· Provide the list of the referenced documents.
· Provide space for any additional documents, references, or supporting materials that the CLIENT wishes to include.

Example:

The referenced documents of the present document is listed as follows:

- [NAME OF DOCUMENT], [AUTHOR, COMPANY, YEAR, BIBLIOGRAPHIC CITE, URL OR ANY OTHER DATA TO ACCESS THE DOCUMENT]
- ...

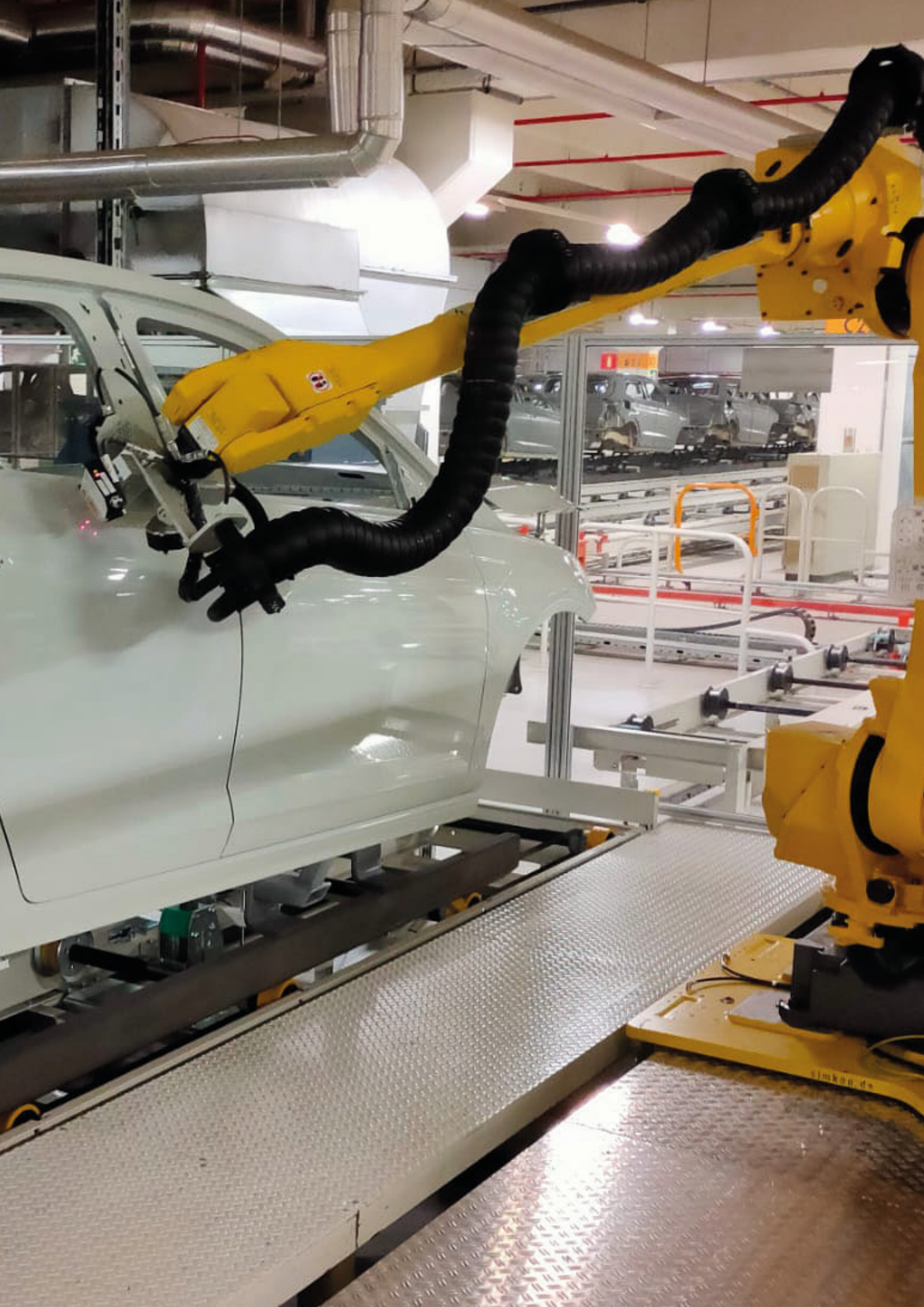
The complete content of important documents related to the present bid is shown below.

- [NAME OF DOCUMENT], [AUTHOR, COMPANY, YEAR, BIBLIOGRAPHIC CITE, URL OR ANY OTHER DATA TO ACCESS THE DOCUMENT], [LITERAL CONTENT OF THE WHOLE OF PARTIAL DOCUMENT]
- ...

9. About the author

das-Nano is the world leader in coating thickness inspection for industry. With a patented, state-of-the-art technology based on terahertz waves, das-Nano is offering leading manufacturers in the automotive, aerospace and semiconductor industries, among others, the ability to be more efficient and ensure the highest quality, making their inspection, characterization, painting or coating processes optimal.

In operation since 2012, **das-Nano** has extensive experience in the industry and has established itself as the global leader in the field of inspection with terahertz waves, being the ideal solution for contactless thickness measurement of coatings, detection of hidden corrosion or electrical characterization of graphene in a non destructive way, among other cutting-edge solutions.



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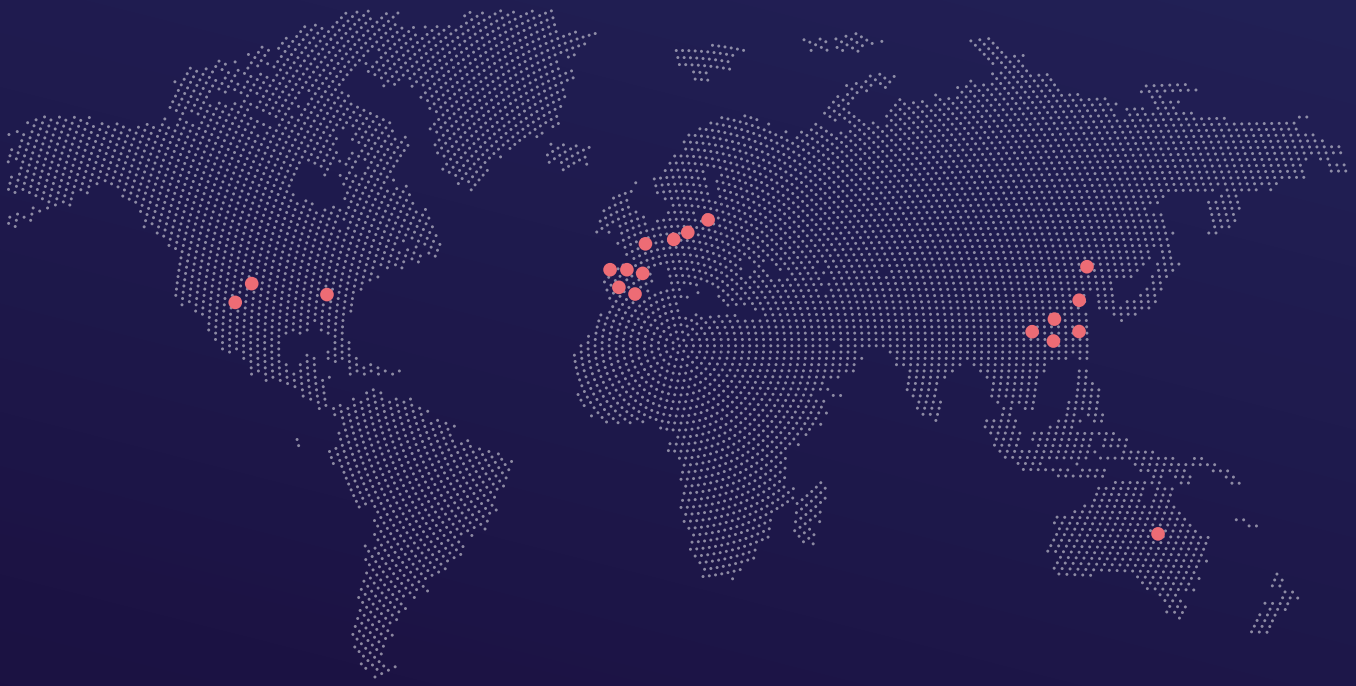

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