INFLUENCE OF THE MEASUREMENT OF ANTI-REFLECTIVE COATING LAYER FOR OPTICAL MEASUREMNT

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ABSTRACT

The aim of this work is to investigate anti-reflective coatings for surface matting and their effect on optical sensing accuracy. In the experimental part, the thickness of the coatings is analyzed on samples with different surface roughness levels: Ra 0.2, Ra 1.7, and Ra 3.1. The samples were milled from C45 steel. Seven types of matting sprays (sublimation and permanent) were tested. The results show that the ATTBLIME AB P spray achieved the lowest average coating thickness of 0.4 µm with a minimal uncertainty of 1 µm for Ra 0.2, making it the most reliable for thin layers. ATTBLIME AB ZERO spray, in contrast, had an average thickness of 19 µm with a higher uncertainty of 17 µm for Ra 1.7. Only ATTBLIME AB P and Helling sprays met the manufacturer's declared parameters across all samples. Permanent sprays, especially ATTBLIME AB P, best suit thin matting layers on glossy surfaces.

KEYWORDS

Anti-Reflective Coating, Mattifying Sprays, Surface Roughness, Measured Layer Thickness, Optical Scanner - Shapetracer II.

1 INTRODUCTION

1.1 The importance of powdering in 3D scanning

Today, modern 3D scanning technologies play a key role in industrial practice and research, with reverse engineering also finding significant applications. Reverse engineering is based on the principles of modern design and advanced measurement technologies. In this process, a scanned 3D product model (typically a polygonal model) is converted into an engineering and conceptual (parametric) model using CAD software This transformation applies not only digital data, but also knowledge of construction and design, allowing the model to be redesigned or recreated based on an existing design. For this purpose, various 3D object reconstruction methods designed for non-contact, e.g., reflective, scanners are used, as described, for example, in [Feng 2001].

The issue of 3D laser scanning has been addressed by a number of experts, including Feng et al. [Feng. 2001], who, in high-speed scanning, investigate not only the complexity of the shape of the components, but also their spatial positioning on the measurement pad. Feng [Feng 2001] in 2001 concludes that for proper reflection of the laser beam, it is necessary to apply an anti-reflective material to the surface. The visibility of the structured light is greatly affected by the material properties and the color of the scanned surface. As stated by Mendricky [Mendricky 2019], for reflective, dark or black surfaces, polarizing filters and polarizing illumination techniques are used to ensure good scanning quality.

The most problematic cases in 3D scanning are glossy, black and transparent surfaces. According According to Pereira et al. [Pereira 2019], it is necessary to apply a coating material to scan mirror and translucent materials, but this negatively affects the accuracy of the measurements Sputter-coated layers of gold, silver, platinum or carbon are commonly used to coat surfaces. Dark surfaces absorb most of the projected light, reducing its reflection back to the sensors. Although scanner sensitivity can be improved in part by adjusting parameters, the use of anti-reflective sprays is recommended to achieve high accuracy. Levinska [Levinska 2017] describes the use of a chalk spray, which is followed by the research of team D. Palousek [Palousek 2015] from Brno University of Technology. This team compared the effect of chalk and titanium powder on the accuracy of 3D measurements and showed through statistical analysis that titanium powder provides less geometric deviation due to a thinner layer. Levinska then compared other anti-reflective materials (e.g., developer, cyclodecane powder) and confirmed that titanium powder provides the highest measurement accuracy.

The application of anti-reflective coating or surface matting is a crucial technological step in the optical measurement of components with glossy or transparent surfaces where conventional optical methods fail without this treatment. In many cases, it is the only effective way to obtain accurate dimensional data. The matting is normally done by airbrush technique, i.e. by air gun, or by anti-reflective spray powders which create a fine, thin and diffuse layer on the surface This treatment eliminates specular reflections and allows the light needed for accurate sensing to be dispersed evenly. An alternative approach is described by Maeng and Lee [Maeng 2016], who focus on the electrostatic application of powder layers. In this case, the powder is charged with a negative charge while the surface of the object is grounded, causing the powder material to adhere due to electrostatic force. This method allows for more uniform coverage and potentially lower material consumption. However, the main disadvantage of electrostatic deposition is its limited applicability to non-conductive materials such as glass or rubber, where a sufficient potential difference cannot be created for particle adhesion.

In their study, Franke et al. [Franke 2022] compare the properties of sublimation scanning sprays under uniform deposition conditions. To ensure repeatability and eliminate the human factor, they use an automated spray system with a spray gun based on a vibrating membrane atomizer. The aim was to evaluate the effect of coating thickness and sublimation time on the scanning quality of glossy surfaces. All experiments were conducted under constant laboratory conditions to minimize the effect of the environment on the properties of the deposited coating. A mixture of titanium dioxide (TiO_2) and ethanol was used as the coating material. Phase Doppler anemometry was applied to analyze the dispersion and particle behavior during deposition, which allowed a detailed evaluation of particle size and dynamics. The measured parameters were subsequently compared with the results of 3D scans performed on such treated surfaces.

The study confirms that the quality of 3D scanning is closely related to the quality and homogeneity of the coating applied. It was found that a greater coating thickness generally improves the quality of the scan data as it provides better diffusion and eliminates glare. On the other hand, too thick coatings can negatively affect the accuracy of the measurements by altering the actual dimensions of the object. Therefore, the optimal coating thickness must be chosen with respect to the trade-off between scan quality and dimensional accuracy.

A similar method is investigated by Hrubos et al. [Hrubos 2019], who focus their study on matte coatings designed for 3D scanning purposes. In their experiments, they use a mixture of titanium dioxide (TiO_2) and ethanol and compare the properties of coatings applied using a newly designed spray gun with a membrane atomizer versus a commonly used standard spray gun. The aim of their research is to evaluate the matting effect, the resulting coating thickness and the effect of different TiO_2 particle sizes on the resulting surface quality.

The study shows that the particle size in the raw powder may not always be the key parameter for the resulting properties of the layer. During the spraying process, various factors can significantly affect the structure of the deposited layer, which has a direct impact on its quality and properties. The results suggest that the optimization of the application technique and spray parameters may in some cases be more important than the properties of the starting powder material itself.

One of the key factors in surface matting is the thickness of the applied layer. The goal of spray matting application is to create the thinnest layer that is optically detectable while sufficiently improving the optical properties of the scanned surface. A layer that is too thick can have a negative effect on the accuracy of the measurement as it affects the geometric dimensions of the scanned object. In the most commonly used spray matting method, the thickness of the layer depends on several factors, such as the spray time, the distance of the spray from the surface of the part or the pressure setting, which have a direct influence on the uniformity of the application and the properties of the resulting layer.

The research work is experimentally focused on comparing different types of anti-reflective sprays in terms of coating thickness and their effect on the accuracy of 3D optical scanning of surfaces with different roughness. The research conducted confirms that the application of anti-reflective coatings is crucial for ensuring the accuracy of optical 3D scanning, especially for shiny, dark or transparent surfaces. For example, a study published in the Materials Science Forum emphasizes that before starting 3D scanning, it is often necessary to cover the surface of the measured object with a thin layer of anti-reflective material in order to minimize light reflections and improve the quality of digitization. For our research focused on anti-reflective coatings for matting surfaces and their effect on the accuracy of optical scanning, there are several current scientific studies that confirm the importance of this issue. In 2023, Impact of Powder Coating Types on Dimensional Accuracy in Optical 3D Scanning Process [Milde 2023] was published in MM Science Jurnal, focusing on the influence of different types of powder coatings on dimensional accuracy in optical 3D scanning. The results show that the type of coating used can significantly affect the measurement accuracy, especially for glossy and reflective surfaces. Jakub Franke [Franke 2023] compared eight sublimation scanning sprays in terms of their effect on 3D scanning results, coating thickness and sublimation time. All materials used allowed the capture of the highly reflective surface of the silicon wafer. However, the differences between some sprays were significant. Measurements of the sublimation time showed that all coatings completely disappeared from the surface of the silicon wafer. However, all coatings left visible traces on the mirror surface. In 2019, Pereira et al. [Pereira 2019] proposed the use of gold, silver, platinum and carbon by sputtering to coat scanned surfaces. The effects of these materials on the accuracy of three-dimensional scanning were evaluated and compared with the effects of two frequently used materials, namely talc and non-aqueous wet developers for penetrant testing. To verify the resulting geometric variations, samples were scanned before and after the application of each coating material.

The specialization in the section of non-contact measurement using cameras and anti-reflective sprays is comprehensively unexplored and requires further experimental and research work that will deal with the comparison of measuring instruments or measurement methodologies. Our stated goal to compare different anti-reflective sprays from different manufacturers and check their true indication of the powder layer applied was met, the work is enriched by the fact that we performed all tests on different roughnesses, because we know that surface roughness plays a major role in the use of anti-reflective powders.

2 METHODOLOGY

All anti-reflective layers were applied manually. For the experimental part, a preparation was made, see Fig. 1. The preparation is made of polylactic acid (PLA) - PLA (biodegradable). The distance of the spray nozzle from the experimental samples is 250 mm.

Figure 1. Preparation from the FDM 3D printing method, the distance between the nozzle and the samples is 250 mm

The initially selected injection time was 3 seconds. However, after the first measurement, it turned out that the layer of applied material was too thick and significantly affected the measurement results, on the order of tens of micrometers. Therefore, the spraying time was reduced to 1.5 seconds.

2.1 Types of spray and their division

Matting sprays are divided into two main groups according to their characteristics, but also according to the method of spraying. The two main types of sprays are sublimating and permanent. Spraying can be done with a spray gun (airbrush method) or by using matting powders in sprays. There are many divisions and categorizations of matting sprays, see below.

2.1.1 Distribution of sprays according to composition

1. Silicone anti-reflective sprays: Contain silicone polymers that form a thin layer on the surface, reducing reflectivity.

2. Aqueous anti-reflective sprays: These sprays use a water base and may contain various polymers or other substances that reduce reflections.

3. Dispersion anti-reflective sprays: nanoparticles that help reduce reflections and glare by scattering light on the surface.

These nanoparticles can be made from a variety of materials such as silicon, metal oxides, or polymers.

4. Polymer anti-reflective sprays: often called transparent sprays, these are applied to a surface to form a thin, invisible layer that reduces reflectivity. These can be different types of polymer resins such as acrylics, silicones or polyurethanes.

2.1.2 Classification of sprays by degree of matting

- **Mild matting:** Sprays that reduce mild reflections and glare, commonly used for standard optical equipment.
- **Strong matting:** These sprays have a greater effect in reducing reflections and glare and are suitable for situations where stronger protection against reflections is needed.

2.1.3 Classification of spray by durability and repeatability

Sublimating sprays: They provide anti-reflective effects after a single application but require regular renewal, as their effect completely disappears after a certain period.

Sublimating sprays can be based on various substances, most commonly cyclodecane, chalk, or titanium. The sublimation time ranges from 1 to 24 hours, while the complete evaporation time, leaving no residue, typically takes a few additional hours.

The use of sublimating sprays depends on the specific type of spray and the intended application. However, the general guidelines listed below should be considered when using sublimating sprays:

- **Surface preparation**: Before applying the sublimating spray, the surface must be thoroughly cleaned to ensure proper adhesion and effectiveness of the spray.
- **Application**: Sublimating sprays are typically applied as a thin film by spraying. It is important to follow the manufacturer's instructions regarding the proper spraying technique and distance from the surface.
- **Ventilation:** The application of sublimating sprays should take place in a well-ventilated area to minimize inhalation of vapors and aerosols.
- **Temperature and humidity:** Air temperature and humidity can affect the application process and the resulting effectiveness of the spray. It is recommended to apply the spray under optimal temperature and humidity conditions as specified by the manufacturer.
- **Safety precautions:** It is important to follow the safety instructions provided on the spray packaging, including eye, hand, and respiratory protection.
- **Storage:** Sublimating sprays should be stored according to the manufacturer's instructions, typically in a cool and dry environment, away from direct sunlight and heat sources.

Permanent / durable sprays: These provide long-term anti-reflective effects and do not require frequent reapplication. Permanent or durable matting sprays create a permanent layer after application, which remains on the material until it is cleaned off using appropriate chemicals. This type of spray is suitable for cases where high scanning accuracy is required, and where cleaning of the component is not an issue. This solution is traditional and proven by long-standing industrial practice. An example of this group is titanium dioxide powder.

2.2 Variants sprays for the experimental section

In the experimental section, different types of sublimating and permanent sprays (Fig. 2) and their variants (Tab. 1), which were used to create a matting layer on the surface of the samples, were employed. The selection of a specific spray type was made considering the desired properties of the layer, such as temporary nature, uniformity of application, evaporation rate (for sublimating sprays), and resistance to mechanical abrasion (for permanent sprays). These parameters had a direct impact on the quality and reliability of the subsequent optical measurement.

NAME	ATTBLIME AB ZERO	ATTBLIME AB 2	ATTBLIME AB 6	ATTBLIME AB P (GRAY)	AESUB ORANGE	AESUB WHITE	HELLING 3D SCAN
SCAN TIME	up to 1 hour	up to 2 hours	up to 6 hours	unlimited	up to 8 hours	unlimited	unlimited
COLOR	gray	gray	gray	gray	-	-	-
SUBLIMATING / PERMANENT	SUBL.	SUBL.	SUBL.	PERM.	SUBL.	PERM.	PERM.
DURABILITY OF THE SPRAY	1-2 hour	1-2 hour	6-10 hour	-	12-24 hour	-	-
LAYER THICKNESS	2.9 µm	3 µm	6.5 µm	7 µm	2-6 µm	7 µm	2.8 µm
PRICE (EXCLUDING VAT)	538 CZK	563 CZK	688 CZK	288 CZK	1299 CZK	1299 CZK	533 CZK

Table 1. Comparison of matting spray variants

Figure 2. Selected mattifying sprays (from left: ATTBLIME AB ZERO, ATTBLIME AB 2, ATTBLIME AB 6, ATTBLIME AB P, AESUB ORANGE, AESUB WHITE, HELLING 3D scan spray)

2.2.1 Types of sprays

For the experimental part, the following types of sprays were considered:

ATTBLIME AB ZERO
Cyclodecane spray powder, sublimating, designed to be scanned within 1 hour. Complete evaporation of the spray is within 2 hours. It is suitable for small and medium objects.

ATTBLIME AB 2
Cyclodecane spray powder, sublimating, designed for scanning within 2 hours. Suitable for small and medium objects.

ATTBLIME AB 6
Cyclodecane powder spray with a coating durability of 6 hours from application to complete evaporation. Suitable for measuring objects of all sizes. The layer thickness varies depending on the chosen spraying technique.

ATTBLIME AB P
Permanent spray based on natural dyes with a very thin application layer of 7 µm. Suitable for measuring objects of all sizes.

AESUB ORANGE
Sublimating spray used for high-precision measurements. This spray does not contain titanium dioxide or pigments. It is used for measuring components of all sizes.

AESUB WHITE
Sublimating spray used for high-precision measurements. This spray does not contain titanium dioxide or pigments. It is used for measuring components of all sizes.

HELLING 3D SCAN SPRAY
Permanent spray containing calcium oxide (chalk powder). Excellent for covering glossy surfaces with easy cleaning without the use of chemicals.

2.3 Issues with the applied layer of matting powder

The layer of applied spray powder can have several different impacts on the scanning process and the resulting images or measurements. Here are some of the possible effects:

- **Reduction of reflections and glare:** The primary purpose of applying a matting spray is to reduce reflections and glare from the surface of the sample. This can lead to clearer and more consistent images, improving image quality and allowing for more accurate measurements.
- **Improvement of contrast:** Sprays can also enhance the contrast between the sample and the background or surrounding environment. This can be useful for visualizing sample details or for image analysis.
- **Surface texture:** The spray layer can also add texture to the surface of the sample, which may affect the appearance and behavior of light on this surface. This texture can be significant, especially in microscopic or macroscopic analyses.
- **Measurement accuracy:** When using a matting spray, it is important to consider its thickness and uniformity. Inaccuracies in thickness or uneven coverage can lead to distortion of the resulting measurements or images.
- **Potential interference with surface details:** In some cases, the spray layer may obscure fine surface details of the sample, which can be undesirable, especially if these details are of interest**.**

Proper application of matting sprays can significantly contribute to improving image quality, increasing contrast, and reducing reflections. However, to achieve optimal results, it is essential to carefully assess the impact of the spray on the specific application and select the appropriate type of spray and application method, considering the required measurement parameters.

3 RESULTS

The experiment investigates the effect of surface roughness of test samples and applied layers of matting sprays on subsequent optical measurements, particularly on the surface detectability. The matting spray was applied to the prepared test samples. As shown in Fig. 3, the samples consist of three cuboids with dimensions (80 × 30 × 5) mm, each with a different surface roughness value. The roughness of the first sample is Ra 0.2 µm, the second Ra 1.7 µm, and the third Ra 3.1 µm. The material used for the production of the samples is non-alloyed quenched steel C45.

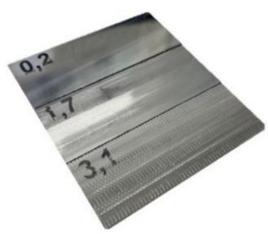

Figure 3. Test samples with different roughness, the roughness is indicated on the samples [µm]

3.1 *Layer thickness measurement*

The thickness of the layer is measured using the Alicona Focus G5 microscope, with the device parameters provided in Tab.2.

Lens magnification	5x	10x	20x
Lateral x,y measurement range [mm]	2.82	1.62	0.81
Vertical resolution [nm]	410	100	80
Minimum measurable profile roughness (Ra) [µm]	1.2	0.3	0.15

Table 2. Alicona Focus G5 parameters

To achieve magnification and create a 3D surface, multiple magnification options were used, as shown in Fig. 4–6. The red bar shows the areas that were used to measure the coating thickness.

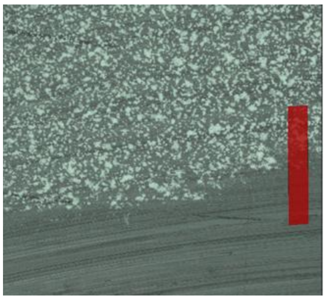

Figure 4. Magnification 5 times

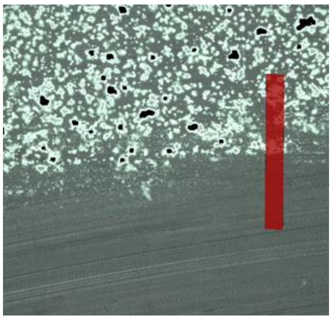

Figure 5. Magnification 10 times

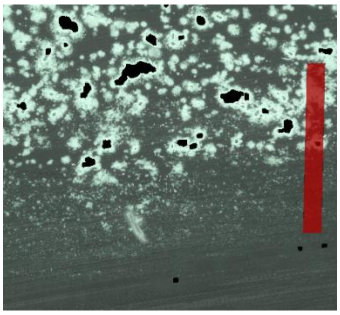

Figure 6. Magnification 20 time

	5x zoom		10x zoom		20x zoom	
Measurement 5 times	Ra [µm]	Rz [µm]	Ra [µm]	Rz [µm]	Ra [µm]	Rz [µm]
$\bar{X}$[µm]	0.227	0.872	0.261	1.158	0.286	1.399
S(x) [µm]	0.024	0.141	0.035	0.269	0.077	0.353
u_A [µm]	0.001	0.020	0.001	0.072	0.006	0.125

Table 3. Measured values at individual magnifications Ra 0.2

From Tab. 3, it is clear that the values at fivefold magnification have the smallest difference in measured values, therefore this magnification is chosen as the most suitable. After this analysis, we proceed to the actual measurement of the layer thicknesses of individual sprays, as shown in Table 4. Each measurement is performed five times, and the standard deviation $S_{(x)}$ and the standard uncertainty of type A - u_A are subsequently evaluated.

Spray used	Layer Thicness [µm]	Ra [µm]	$\bar{X}$ [µm]	$S_{(x)}$ [µm]	u_A [µm]
ATTBLIME AB ZERO	2.9	Ra 0.2	12	24	11
		Ra 1.7	19	37	17
		Ra 3.1	8	17	8
ATTBLIME AB 2	3	Ra 0.2	5	10	5
		Ra 1.7	5	11	5
		Ra 3.1	7	13	6
ATTBLIME AB 6	6.5	Ra 0.2	4	8	4
		Ra 1.7	7	14	7
		Ra 3.1	7	14	7
ATTBLIME AB P	7	Ra 0.2	0.4	1	1
		Ra 1.7	3	5	3
		Ra 3.1	7	14	6
AEBUS ORANGE	2 - 6	Ra 0.2	5	10	5
		Ra 1.7	6	12	6
		Ra 3.1	7	6	6
AEBUS WHITE	7	Ra 0.2	14	29	13
		Ra 1.7	2	3	2
		Ra 3.1	5	10	5
HELLING	2.8	Ra 0.2	1	3	2
		Ra 1.7	2	3	2
		Ra 3.1	2	3	2
SUBLIMATING					
PERMANENT					

Table 4. Layer thickness measurement

3.2 *Measuremnt of detectability on 3D CMM*

For scanning, the Wenzel LH65 X3M Premium measuring machine with the Shapetracer II optical line scanner was selected. Its parameters are provided in Tab. 5.

Optical scanner parameters - Shapetracer II.		
Parameters	**Value**	**Units**
Accuracy	0.02	mm
Scan speed	100	points/s
Increment	0.1	mm
Exposure time	0.44	s
Working distance	80	mm
Working range	120	mm
Software	PointMaster	

Table 5. Optical scanner and its parameters

The sample scanning was carried out along a single trajectory of the scanning laser. In Fig. 7, two areas for comparison purposes are marked with the letters A and B. These correspond to the part on which the matting spray was applied. In the area of point A, the thickness of the spray layer is in the range of hundreds of micrometers.

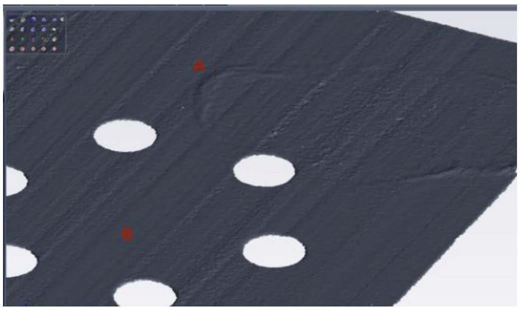

Figure 7. Scan of a part with a different coating layer

Surface roughness plays a significant role in optical or laser measurements, as seen in Fig. 8, where a milled sample with a roughness of Ra 0.2 cannot be scanned without the matting layer. On the other hand, for a roughness of Ra 3.1, a data set can be generated from which a surface for measuring distance could be created, but it is insufficiently measured for evaluating geometric tolerances or surface roughness. On samples with roughness values of Ra 1.7 and Ra 3.1, milling traces can be seen, and at the outermost points, the surface is so shiny that it is impossible to scan. However, in the middle of the milling path, the surface is rough enough for scanning. This indicates that even with a roughness of Ra 3.1, using a matting spray is appropriate for accurate measurements.

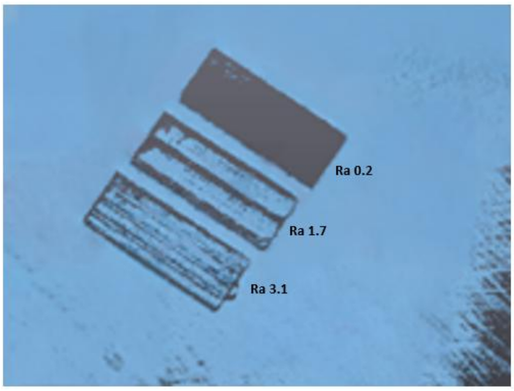

Figure 8. Scanning samples without treatment with a reflective layer

The scanning of the samples was performed using a single pass for all samples.

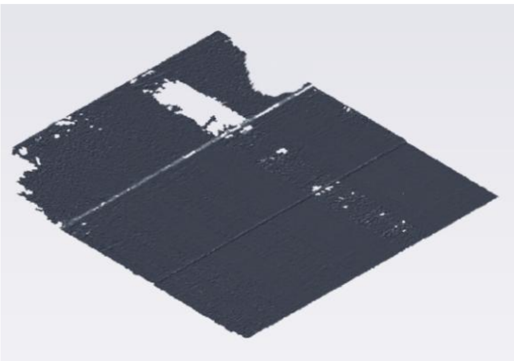

Figure 9. Sample with applied spray ATTBLIME AB ZERO

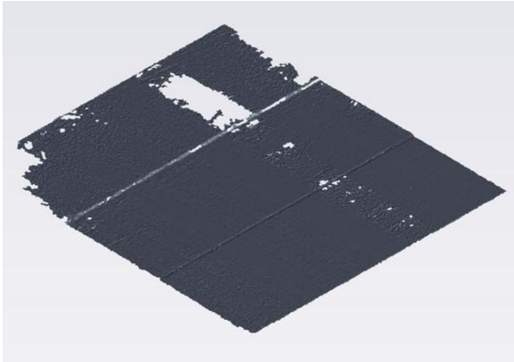

Figure 10. Sample with applied spray ATTBLIME AB 2

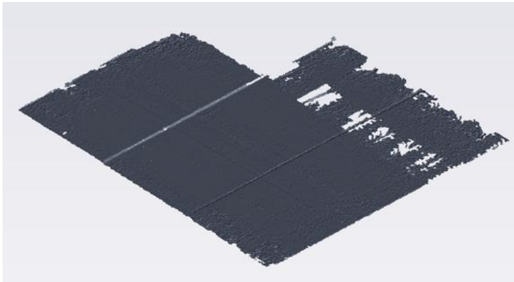

Figure 11. Sample with applied spray ATTBLIME AB 6

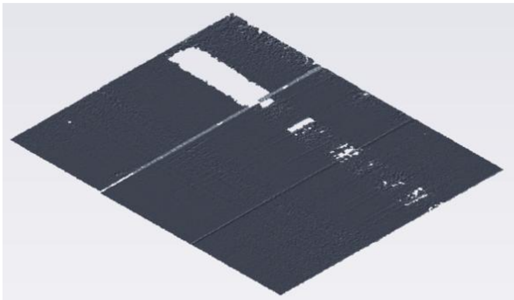

Figure 12. Sample with applied spray ATTBLIME AB P

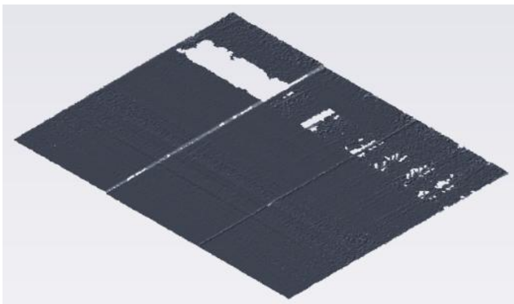

Figure 13. Sample with applied spray AESUB orange

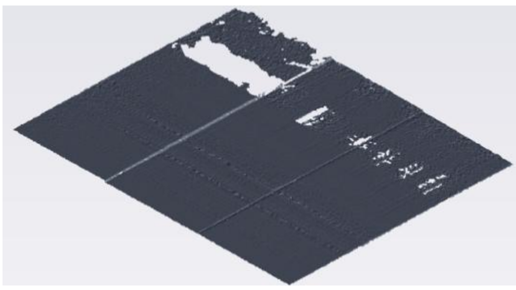

Figure 14. Sample with applied spray AESUB white

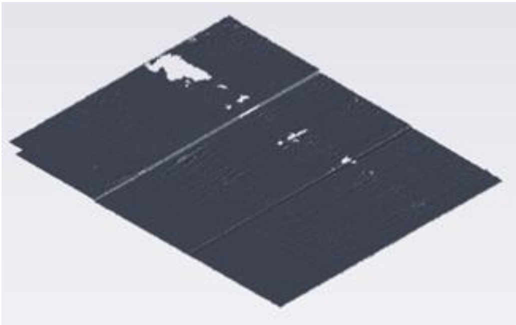

Figure 15. Sample with applied spray HELLING

Fig.	Condition	Description of the problem
9.	NOK	The sample with a roughness of Ra 0.2 results in flare at both ends of the sample. The surface is therefore not perfectly sensed when using ATTBLIME AB ZERO spray.
10.	NOK	The sample with a roughness of Ra 0.2 causes glare at the extreme points and the surface is therefore not perfectly removable when using ATTBLIME AB 2 spray.
11.	NOK	The sample with a roughness of Ra 0.2 is not perfectly imaged using ATTBLIME AB 6 spray.
12.	OK	The surface of the entire test specimen is readable except for very minor defects. The matting on this sample was carried out using ATTBLIME AB P permanent spray.
13.	OK	The anti-reflective coating applied with AESUB orange spray is very easy to remove.
14.	NOK	The sample with a roughness of Ra 0.2 is not perfectly imaged when using the AESUB WHITE spray.
15.	OK	Despite minor imperfections, the surface was largely scannable. A chalk-based spray from HELLING was used in this case.

Table 6. Description of samples with applied sprays

- ATTBLIME AB P + Helling –The values of the covering layer given by the manufacturer for these types of spray are confirmed and satisfactory. Even values in the order of micrometers smaller than the manufacturer's stated values were measured.
- ATTBLIME AB P – The lowest average values recorded for the spray (0.4 µm) with the smallest associated uncertainty uA(1 µm) for a roughness Ra of 0.2. Based on the obtained results, it can be stated that the ATTBLIME AB P spray is the most suitable choice for applications requiring the thinnest possible matting layer when scanning glossy surfaces.
- ATTBLIME AB ZERO – The highest average measured values (19 µm) with the highest associated uncertainty uA (17 µm) for a roughness of Ra 1.7. This finding shows that the spray is not capable of repeatedly applying precise, continuous and thin layers and is therefore less reliable and stable in terms of the accuracy of the applied matting layers.
- ATTBLIME AB 6 – The layer thickness was lower only for the sample with a roughness of Ra 0.2, while for higher roughness levels the difference from the declared value was larger, in the order of tenths of micrometers, see Table 4.
- AESUB WHITE – Meets the required conditions only for samples with roughness values of Ra 1.7 and Ra 3.1. For the sample with roughness Ra 0.2, the measured layer thickness was 7 µm greater than the value stated by the manufacturer, see Tab. 4.
- AESUB ORANGE – Met the conditions for the sample with Ra 0.2, while for samples with roughness values of Ra 1.7 and Ra 3.1 the differences were larger, although only by a few tenths of a micrometer, see Tab. 4.
- ATTBLIME AB 2 – Larger differences were observed compared to the declared values across all roughness levels, on the order of a few micrometers, see Tab. 4.

The extension of the scientific part to the next experiment is robotic compression of the spray, for precise determination of the spraying time. Focus more on less roughness and try other machining methods or different 3D printing methods (SLS, FDM, SLA, SLM,….). I also recommend using a multi-beam laser such as the Handyscaner, which has 17 laser lines, or the structured light method such as the Zeiss Atos Q measuring machine.

CONCLUSION

The aim of the experiment was to determine the appropriate type of matting spray for optical measurement of surfaces with different roughness after milling operations. Based on the results shown in Fig. 9–15, the most suitable matting spray for all cases cannot be clearly determined. When focusing on samples with the lowest roughness Ra 0.2, it was possible to select sprays with good coverage capability while maintaining a minimal layer thickness, which was the main parameter analyzed in this experiment. Samples with higher roughness values, specifically Ra 1.7 and Ra 3.1, exhibited sufficient measurability in all cases.

In conclusion, it can be stated that using our measurement method, the coating thickness results for the selected sprays confirmed that surface adhesion and roughness influence the accuracy of the measured surface. It was demonstrated that the permanent spray ATTBLIME AB P exhibits better properties compared to sublimating sprays. It would be appropriate to evaluate it further and conduct experiments at different distances and with varying spray durations, or to perform a comparison with titanium powder applied using an AirBrush gun, which shows superior properties of the deposited layer.

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