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OPTIMIZING ADDITIVE MANUFACTURING OF COCR DENTAL ALLOY: ENHANCED PRODUCTIVITY WHILE MEETING ISO 22674 MECHANICAL REQUIREMENTS

Cosmin COSMA, Stelian LIBU, Alexandru POPAN, Mircea DUDESCU, Nicolae BALC

Abstract: This study investigated the SLM parameter to increase productivity while meeting ISO 22674 mechanical requirements for dental applications (≥ 500 MPa yield strength, $\geq 2\%$ elongation). Six parameter sets (M1–M6) were tested. The optimized M5 set (30 μm layer thickness, 85 W laser power, 960 mm/s scan speed, 50 μm hatch spacing) doubled the build-up rate from 0.77 mm³/s to 1.44 mm³/s compared to M1. As-built samples showed 1074–1298 MPa yield strength but only 1.4% elongation. After stress relief treatment (800 °C, 1 h), M5 samples reached 802 MPa yield strength and 2.9% elongation, meeting ISO 22674. Practical validation included 18 dental bridges with proper fit and surface quality. The M5 parameters are compatible with older SLM machines (≤ 100 W), underscoring the practical relevance and potential impact on productivity.

Key words: SLM parameters; CoCr alloy; build-up rate; mechanical properties; ISO 22674 requirements.

1. INTRODUCTION

Selective laser melting (SLM) process is part of metal Additive Manufacturing (AM), and this fabrication procedure is non-polluting, produces no toxic residues, and prevents material waste [1-3]. An SLM machine is typically equipped with an Nd:YAG laser. Based on the “layer-by-layer” principle, the laser beam melts each powder slice. In this way, it is possible to build functional parts from advanced gas atomization powders.

The main medical applications of SLM printed parts are patient-specific solutions, manufactured from biomaterial alloys such as titanium [4], stainless steel [5,6], or cobalt-chromium (CoCr) alloys [7]. The SLM fabrication method has rapidly penetrated the dental field, where metal-ceramic restorations are currently produced. Typical CoCr applications include dental bridges, prostheses, and abutments [8-10]. Because dental components often feature complex geometries and thin inner walls, special attention must be given to layer thickness. For CoCr dental components, the typical layer thickness is 20 μm

to achieve the high surface accuracy required in these custom applications [11]. However, employing such thin layers also slows down the build process and reduces overall production efficiency.

Various approaches can be employed to enhance the build-up rate and overall productivity of SLM systems. The first approach is using multiple lasers within a single machine. In this manner, the scanning area is divided in two or four regions, where each laser scans a specific zone. Recent examples of machines with two or four laser sources are: SLM 280 (2x400 W or 2x700 W), SLM 800 (4x400 W or 4x700 W), LASERTEC 30 Dual SLM (2x600 W or 1000 W), TruPrint 2000 (2x300 W), MySINT 100 Dual Laser (2x200 W), EVEMET 200 (2x300 W). These advanced SLM machines are manufactured by SLM Solutions, DMG Mori (formerly Realizer), Trumpf, and Sisma.

The second approach is to increase the laser power, which allows higher scanning speeds and larger layer thicknesses (e.g., 50–100 μm). This method is effective for metallic parts where surface finish requirements are less stringent [4,9]. However, for dental applications, the layer

thickness should not exceed 30 μm due to the need for high precision and low surface roughness. From this perspective, a layer thickness of up to 30 μm should be investigated, as it may improve the build rate of CoCr dental parts compared to the standard 20 μm thickness. At the same time, adjusting the layer thickness requires a corresponding adaptation of laser parameters to obtain fully dense pieces. Furthermore, assessing the impact of SLM process parameters on the physical and mechanical characteristics of the material is crucial because CoCr printed components must meet the requirements outlined in ISO 22674 for dental metallic materials used in fixed and removable restorations [12]. According to this standard, CoCr parts SLM-printed must meet the following minimum requirements: 0.2% yield strength, 2% elongation at fracture, and a Young's modulus of 150 GPa.

The purpose of this work was to improve the SLM productivity of CoCr dental parts by adapting the laser parameters for a 30 μm layer thickness, while maintaining the mechanical characteristics in accordance with the requirements of ISO 22674.

The SLM parameters investigated were laser power, scanning speed, and hatch distance. To assess their impact, the mechanical properties were measured (tensile strength and elongation at fracture). The novelty of this study is the adaptation of SLM parameters for an increased layer thickness up to 30 μm , which significantly improve CoCr production using one laser source SLM system.

2. MATERIAL AND METHODS

2.1 CoCr powder and sample design

The powder used is specific to dental restorations and consists of a CoCrWMo alloy produced by Scheftner (Germany). Its commercial name is Starbond Cos 30. The CoCr grains are almost spherical, with diameters between 10 to 30 μm [13]. The chemical composition is shown in Table 1.

In this study, the tensile specimens were designed as shown in Figure 1.

Table 1. Elemental composition of the CoCr powder, as reported in reference [13].

Element	Co	Cr	W	Mo	Si	Other elements (C, Fe, Mn, N)
Percent [%]	59	25	9.5	3.5	1	Under 1.5

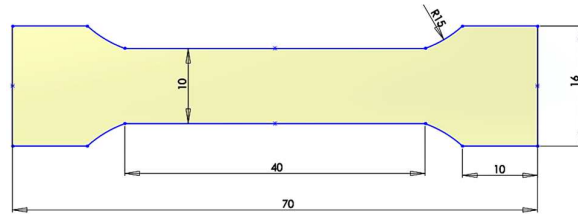


Fig. 1. Geometry of the tensile test specimen with a thickness of 2 mm.

2.2 Laser programming

The SLM process involves spreading successive powder layers using a wiper, which are laser melted according to the defined geometry. The configuration of laser melting functions is illustrated in Figure 2. AutoFab software was used to program the Volume Area function, where the laser power, scanning speed, and hatch spacing are set up. Our preliminary experiments indicated that, for a 30 μm layer and a spot size of 30 μm , the suitable process parameters are: laser power between 50–200 W, scanning speed 300–1000mm/s, and hatch spacing 50–60 μm . The laser parameters of Volume Border function were configured identically to those set for the Volume Area function.

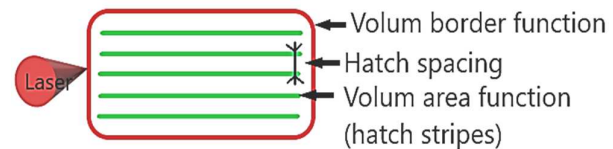


Fig. 2. Laser functions used to program the SLM process in AutoFab software (Sisma machine).

The laser scanning strategies tested in this study were the chessboard and alternating X/Y patterns. The chessboard strategy was recommended by the powder manufacturer [13], and it was applied only to the M1 samples. However, the alternating X/Y fabrication strategy can improve the build rate. For this reason, this study was focused mainly on X/Y scanning strategy.

2.3 SLM manufacturing conditions

To produce the CoCr samples, a Sisma MySINT 100 (Italy) system was used. Based on previous studies [14,15] and our experience in SLM manufacturing [4,9,10], the scanning speed was set at a relatively high level (700–960 mm/s), while the laser power and hatch spacing were adjusted to obtain an energy density between 59 and 90 J/mm³. This energy density range is recommended in several published studies [16,17]. Lower values of energy density may reduce tensile strength due to the formation of micro-pores or incomplete melting of CoCr particles, whereas values above 90 J/mm³ can significantly increase residual stresses or induce heat-affected phenomenon [14].

The SLM parameters used in this study are detailed in Table 2. The volumetric energy density (E) was calculated using Equation (1), and the build rate (or volume build) using Equation (2):

$$E = \frac{P}{v \times h \times t} \left[\frac{J}{mm^3} \right] \quad (1)$$

$$V_b = v \times h \times t \left[\frac{mm^3}{s} \right] \quad (2)$$

where *P* is the laser power (W), *v* is the scan speed (mm/s), *h* is the hatch spacing (mm) and *t* is the layer thickness (mm).

All samples were anchored to the SLM platform using conical support structures with a height of 3 mm. The CoCr samples were fabricated in a horizontal build orientation, as shown in Figure 3. During manufacturing, the oxygen concentration was up to 0.5% in nitrogen atmosphere. Five specimens were fabricated for each SLM condition, resulting in six groups, noted M1, M2, M3, M4, M5, and M6. The processability of each SLM parameter set was evaluated.

2.4 Mechanical testing

Following the SLM fabrication process, the support structures were removed from the samples, and tensile testing was performed using an Instron universal testing machine, in compliance with ISO 6892 standards for metallic materials. The trials were conducted by a loading rate of 2 mm/min, under controlled

conditions of 50% relative humidity and a temperature of 18 °C.

Table 2. SLM process parameters, density energy, and building rate.

Manuf. group	P [W]	v [mm/s]	h [μm]	t [μm]	E [J/mm ³]	V _b [mm ³ /s]
M1	70	700	55	20	90	0.77
M2	85	700	60	25	59	1.05
M3	100	960	50	30	69	1.44
M4	120	960	50	30	83	1.44
M5	85	960	50	30	59	1.44
M6	90	700	60	30	71	1.26

P is the laser power, v is the scan speed, h is the hatch spacing, t is the layer thickness, E is density energy, and V_b is build-up rate.

3. RESULTS AND DISCUSSION

3.1 Build-up rate of SLM process

Six sets of SLM parameters (M1–M6) were tested to improve the build-up rate of CoCr dental applications (detailed in Table 2). The hatch spacing was varied between 50 and 60 μm, an interval that ensures proper overlap and melting of adjacent tracks. Just the M3 and M4 set of SLM parameters led to unstable printing, and the fabrication process was stopped.

The first set of parameters (M1) represents a typical SLM fabrication for CoCr alloy and the laser irradiates the powder with an energy density of 90 J/mm³ (Table 2). Here, a chessboard scanning strategy was operated (squares pattern of 3.3 × 3.3 mm). However, due to the reduced layer thickness (20 μm), the resulting build-up rate was low (0.77 mm³/s).

To improve the build-up rate, five new sets of SLM parameters (M2–M6) were setup and tested (see Table 2). Compared with the first experiment (M1), the M2 configuration employed a 25 μm layer thickness. The laser power and hatch spacing were adjusted to achieve an energy density of 59 J/mm³, resulting in an improved build-up rate of 1.05 mm³/s.

To increase productivity, the layer thickness was raised to 30 μm, with corresponding adjustments of the other SLM parameters to maintain suitable energy density (59-83 J/mm³, M3-M6 parameter sets). In this way, the build-up rates ranged between 1.26 and 1.44 mm³/s

(Table 2). Figure 3 presents an example of samples printed with M5 set of parameters.

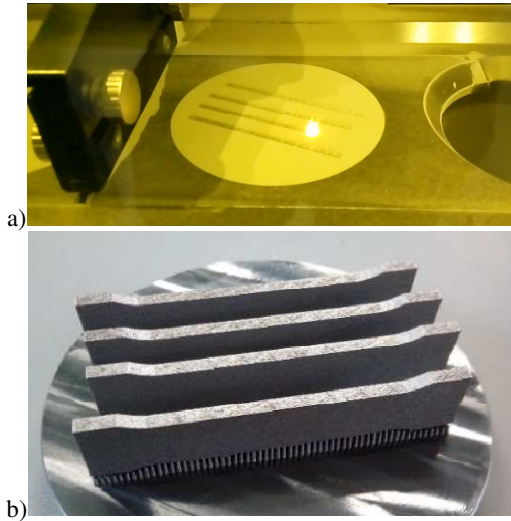


Fig. 3. SLM manufacturing of CoCr specimens: a) M5 samples built with alternative X/Y scanning strategy at 30 μm layer thickness, b) M5 samples after printing, showing their orientation on build plate.

3.2 Mechanical characteristics

Knowing that modifying the SLM parameters impacts mechanical behavior of CoCr pieces, it was mandatory to evaluate them through testing. Table 3 presents the mean values of mechanical properties obtained for each parameter set that ensured stable processability (M1, M2, M5, and M6). It should be noted that these specimens were tested in the as-built condition. Anisotropic behavior was detected in all SLM-manufactured specimens. Furthermore, brittle fractures occurred at tensile stresses above 1100 MPa.

The reference set of parameters (M1) exhibited the following mean properties: 1365 MPa yield strength (YS), 1408 MPa ultimate tensile strength (UTS), and just 1.5% elongation at break. Compared to this typical configuration (M1), the new parameter sets (M2, M5, and M6) showed reduced YS. However, all remained well above the ISO 22674 requirement for dental restorations (minimum 500 MPa). Both the YS and UTS values obtained in this study are approximately twice as high as those reported by the powder manufacturer [13].

Increasing the layer thickness up to 30 μm (M5 and M6) reduce the mechanical performance, with YS ranging between 1074–1134 MPa and UTS between 1158–1219 MPa

(Table 3). The findings indicate that the mechanical behavior is influenced by key build rate parameters, including scanning speed, hatch distance, and layer thickness. When correlating mechanical properties with build rate, the recommended parameter set is M5, as it ensured the highest build rate (1.44 mm^3/s) while maintaining superior YS compared to M6.

Table 3. Mechanical characteristics of CoCr samples SLM-manufactured with different parameters in as-built condition (mean values).

Manuf. group	Yield tensile strength [MPa]	Ultimate tensile strength [MPa]	Elongation at break [%]
M1	1365	1408	1.50
M2	1298	1358	1.39
M5	1134	1219	1.35
M6	1074	1158	1.36
ISO 22674 [12]	Minimum 500	-	Minimum 2

M1, M2, M5, and M6 correspond to the SLM parameters detailed in Table 2 for a stable printing.

3.3 Results validation

After printing, heat treatment is required to increase the elongation at break of CoCr samples in order to meet the ISO 22674 requirements (>2%). A heat treatment under an argon atmosphere can ensure the desired ductility (e.g., heating rate of 400 $^{\circ}\text{C}/\text{h}$ up to 800–1150 $^{\circ}\text{C}$, hold for 1h, followed by cooling down to 300 $^{\circ}\text{C}$ [10,18]). Moreover, Sing et al. recommended a cyclic heat treatment to further improve the mechanical properties of SLM-manufactured CoCr parts (e.g., preheating at 815 $^{\circ}\text{C}$ for 4h, solution treatment at 1220 $^{\circ}\text{C}$ for 1h, followed by rapid water quenching [8]). Such cyclic treatments can shift the fracture mechanism from brittle to ductile, with elongation increasing from approximately 5% to 20%.

To validate the obtained results and to improve the elongation at break above 2%, an additional five samples were printed using the M5 SLM parameters. Post-processing involved a stress relief heat treatment, where the specimens were heated to 800 $^{\circ}\text{C}$ over a 45-minute period, maintained at that temperature for 60 minutes, and subsequently air-cooled [13]. The mechanical results of these samples are detailed in Table 4, and the recorded tensile

stress–strain curves are presented in Figure 4. In the as-built condition, the specimens exhibited exceptionally high YS (1134 MPa), exceeding ISO 22674 requirements and the Scheftner reference values (see Table 4). After stress relief treatment, the YS and UTS decreased to 802 MPa and 1081 MPa, respectively, but the ductility improved to 2.9%, thereby surpassing the ISO threshold (Table 4). This balance underscores the importance of post-processing heat treatment. Overall, the results confirm that optimized SLM parameters, combined with proper thermal treatment, can provide a clinically viable pathway for cost-effective dental manufacturing.

To validate these SLM parameters in a practical scenario, 18 dental bridges and 21 test samples were successfully fabricated (Figure 5). The production time for this job was 8h:25min. Following the printing process, the components underwent stress relief heat treatment at 800 °C for 1 hour, followed by alumina sandblasting to refine the surface. The surface quality was inspected microscopically and found to meet the with dental requirements. Moreover, the fitting between the fabricated dental bridges and the corresponding tooth models was evaluated, showing an appropriate and accurate fit.

Using the M5 process parameters, the NovaMind dental lab can fabricate two full production cycles within 24 hours, significantly improving the efficiency of the Sisma machine, which operates with a single laser. When the SLM build plate is fully loaded with 90–100 dental components, the entire batch can be printed in less than 12 hours. This allows the lab to start a second print job within the same day, enabling faster delivery of CoCr prosthetics to clients.

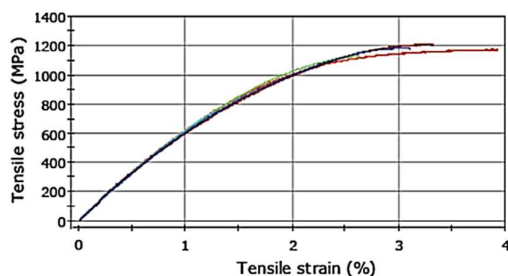


Fig. 4. Tensile stress–strain curves of CoCr samples manufactured by SLM using the M5 parameter set after stress relief treatment.

Table 4. Mechanical characteristics of CoCr samples SLM-manufactured with M5 parameters (mean values).

Manuf. group	Yield tensile strength (YS), Rp0.2 [MPa]	Ultimate tensile strength (UTS), Rm [MPa]	Elongation at break [%]
M5 as-built	1134	1219	1.35
M5 after stress relief treatment	802	1081	2.9
ISO 22674 requirements [12]	Min. 500	-	Min. 2
Scheftner specifications [13]*	720	990	10

*Scheftner is the CoCr powder producer, and the mechanical characteristics were taken from the technical data sheet.



Fig. 5. Validating the results: dental bridges and test samples SLM-manufactured using the M5 set of parameters, demonstrating increased productivity (1.44 mm³/s).

3.4 Comparison with other studies

Table 5 presents and compares the main SLM parameters and their corresponding build-up rates. In addition, the highest values of YS and UTS are summarized. All these experimental results were obtained using CoCr powders. The build-up rates were calculated according to Eq. (2), and it vary between 0.7 and 2.0 mm³/s.

The present build-up rate (1.44 mm³/s) is higher than the one reported by Lu et al. [16] and comparable to several other studies (Table 5). An exception was noted by Sing et al. [8], who achieved a build-up rate of 4 mm³/s by employing a high laser power (360 W) combined with a 50 μm layer thickness. However, such parameters may compromise the dimensional accuracy of dental parts produced under these conditions. From mechanical perspective, the heat-treated SLM specimens showed similar YS and UTS to most reported results (Table 5). In some cases, the current YS exceeds earlier data by 10–30%. Compared to the findings of Sing et al. [8], who applied heat treatment at 1220 °C for 1–4 hours, the present YS and UTS values are approximately twice as high (see Table 5).

On the other hand, Ayyıldız et al. reported tensile strength values approaching 1500 MPa for CoCr specimens manufactured on a Concept

Laser system using Remanium powder [19]. However, the absence of detailed SLM parameters such as laser power or scanning speed makes it difficult to assess the corresponding build-up rate and limits the reproducibility of their findings.

Moreover, Table 5 details the mechanical properties of various cast CoCr materials used in dental applications [20], where the YS and UTS range between 450–700 MPa and 750–1000 MPa, respectively. Comparable values have also been reported for CoCr parts obtained via milling and post-sintering methods [21,22]. By contrast, the present results confirm that the SLM-manufactured samples using the M5 parameter set exhibit superior tensile properties compared to both cast and milling–sintering methods (Table 5). This enhanced tensile strength observed in the M5 samples can be attributed to the high relative density as well as the chosen building orientation. In general, a horizontal orientation of samples on the SLM platform tends to increase tensile strength, since the loading direction is parallel to the layer structure. Furthermore, the rapid solidification inherent to the SLM process refines the microstructure, resulting in a fine cellular–dendritic morphology that further contributes to higher strength values [10]. As previously

Table 5. Comparative analysis of mechanical performance and build-up rates for CoCr samples fabricated via SLM using various parameter sets.

Layer thickness [μm]	Laser power [W]	Scanning speed [mm/s]	Hatch spacing [mm]	Density energy [J/mm ³]	Build-up rate [mm ³ /s]	Yield tensile strength [MPa]	Ultimate tensile strength [MPa]	Source / Condition
30	85	960	0.05	59	1.44	802	1081	This study* / Heat treatment
25	95	700	0.05-0.06	90-108	0.9-1	825-850	1115-1158	[16] / As-built
20	90-126	700-1200	0.05-0.07	53-180	0.7-1.68	573-677	-	[11] / As-built
20	150	700-1200	0.06	104-178	0.84-1.44	700-800	1000-1100	[14] / As-built
30	-	-	-	-	-	655-1002	1052-1262	[18]** / Heat treatment
30	200	75	-	-	-	790	1072	[23] / As-built
30	100	300-600	0.12	46-92	1-2	-	580-830	[17] / As-built
40	20	-	-	-	-	608	1090	[21] / As-built
50	360	500	0.175	83	4.3	450-480	600-650	[8]*** / Heat treatment
Casting method of commercial CoCr: Wironium, Wirobond, Genesis II, IPS d.SIGN, and Vitallium						450-700	750-1000	[20]
Milling of commercial CoCr: Sintron, Amann Girrbach						549	915	[21]
Milling and sintering method of commercial CoCr (SoftMetal LHK)						500-550	1000-1050	[22]

*Samples printed with M5 parameters, after stress relief treatment. **Different orientation of samples on SLM platform (build-up angle between 0°, 30°, 60° and 90°); ***SLM machine with maximum 400 W laser power.

demonstrated [18], horizontally oriented CoCr samples can achieve YS above 900 MPa and UTS around 1200 MPa.

4. FUTURE PERSPECTIVE

The current findings highlight the importance of optimizing SLM parameters for CoCr alloys, both to increase productivity and to maintain superior tensile strength. The findings confirm that superior tensile properties can be attained while increasing productivity by utilizing the M5 parameter set, which includes a 30 μm layer thickness, 85 W laser power, 960 mm/s scanning speed, and 50 μm hatch distance. Notably, this parameter set can be implemented on most SLM systems, including older models with a maximum laser power of 100 W. In this way, by increasing the build rate, the labor costs associated with the manufacturing of dental prosthetics can be reduced.

As previously mentioned, the latest SLM machines dedicated to dental applications are equipped with dual-laser systems of up to 200 W (e.g., MySint 100 Dual Laser, Sisma, Italy). This new generation of SLM systems enables a significant increase in the build rate, as the two lasers operate simultaneously, each scanning different regions of the powder bed. In practice, this parallel scanning strategy reduces the total production time of dental prosthetics by approximately 40–50% compared with single-laser SLM systems. The present M5 set of parameters can double the production rate, increasing from 0.77 mm³/s (M1) to 1.44 mm³/s (M5). In other words, when using this optimized set of SLM parameters in a single-laser system, the resulting productivity is comparable to that of a dual-laser system operated under a typical configuration (20 μm slice thickness). Furthermore, applying the M5 parameters in a dual-laser system can further enhance productivity to a significant extent.

When compared with conventional manufacturing methods [24,25], SLM offers several distinct advantages: it ensures physical–mechanical properties that are comparable or often superior to those obtained by traditional techniques, enables cost-effective production of customized components, and allows the

recycling of un-melted powder. These benefits have accelerated the adoption of AM in the medical field, where customized implants and prostheses are increasingly fabricated [26–28]. Moreover, given the global demand for sustainable products, AM and particularly SLM provides valuable opportunities for material reuse and waste minimization, reinforcing its role as both a technologically advanced and environmentally responsible manufacturing solution [29].

Further studies are needed to investigate additional characteristics of CoCr alloys produced by SLM, such as fatigue strength, corrosion resistance, wear behavior, and bonding performance with ceramics, to validate their long-term clinical effectiveness and durability.

From our perspective, the SLM process holds strong potential to reshape biomedical manufacturing by enabling faster, more flexible, and highly customized production. With their superior mechanical strength and increased build rates, SLM-fabricated parts offer significant cost-reduction advantages, which are expected to drive broader adoption of this technology within the biomedical industry.

5. CONCLUSIONS

Based on the results obtained, the following conclusions can be drawn:

- Improving the layer thickness from 20 μm to 30 μm , along with fine-tuning key SLM parameters such as laser power (85 W), scanning speed (960 mm/s), and hatch spacing (0.05 mm) led to a substantial increase in the build-up rate, from 0.77 mm³/s to 1.44 mm³/s, effectively boosting manufacturing productivity.
- Stress relief heat treatment is mandatory for SLM-fabricated CoCr specimens, since the as-built elongation does not meet ISO 22674. With M5 parameters followed by stress relief (800 °C/1 h), specimens achieved 802 MPa yield strength and 2.9% elongation, thus fulfilling ISO requirements.
- Samples fabricated with the M5 parameter set demonstrated superior tensile properties compared to cast or milled CoCr alloys, and comparable performance to other SLM studies.

► Despite operating with a single-laser Sisma machine, the NovaMind lab can complete two full printing cycles within 24 hours applying M5 parameters. This efficiency enables the rapid fabrication of 90-100 dental components per cycle and supports faster delivery of CoCr substrates to clients.

► Dental bridges SLM fabricated using M5 parameters and post-processed (stress relief treatment and sandblasting) demonstrate adequate surface quality and dimensional accuracy, confirming their clinical applicability.

6. ACKNOWLEDGEMENTS

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NovaMind evolved from NovaDental, a reference company since 1980 in importing and distributing dental products and materials from leading international brands. Today, it is the only Greek company of its kind, specialized in the manufacturing of Titanium Grade 5 implant prosthetics (European certified) and compatible with major dental implants (CEO Giorgos Giannoudovardis). Doted with state-of-the-art machinery, NovaMind operates milling centers for CoCr, zirconia, and laser metal sintering systems (type SLM), producing thousands of dental prosthetics monthly for the Greek, German, and other international markets (www.novamind.gr).

The OpTi-DeP project aimed to optimize 3D printing machines for fabricating customized dental applications using CoCr, improving surface quality, accuracy, and productivity, while transferring advanced additive manufacturing knowledge from research to private companies (<https://optidep.utcluj.ro/>).

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Optimizarea fabricației aditive pentru aliajului dentar CoCr: Îmbunătățirea productivității respectând cerințele mecanice ale standardului ISO 22674

Acest studiu a investigat parametrii fabricației SLM capabili să crească productivitatea, menținând în același timp cerințele mecanice ale standardului ISO 22674 pentru aplicații dentare (min. 500 MPa rezistența limită de curgere și min. 2% alungirea la rupere). Au fost evaluate șase seturi de parametri (M1–M6). Utilizând setul optimizat M5 (grosime strat 30 μm , putere laser 85 W, viteză de scanare 960 mm/s, distanță între hașuri 50 μm), productivitatea a crescut de la 0,77 mm³/s la 1,44 mm³/s comparativ cu configurația tipică M1. Fără tratament termic pentru densionare, rezistența mecanică a fost de 1074–1298 MPa, iar alungirea la rupere de aproximativ 1,4%. După tratamentul de detensionare (800 °C timp de 1 h), probele fabricate cu setul de parametri M5 au avut o rezistență mecanică de 802 MPa și o alungire la rupere de 2,9%, atingând astfel cerințele ISO 22674. Validarea practică a fost realizată prin fabricarea a 18 punți dentare care au avut o calitate bună și o fixare corespunzătoare pe dinții machetă. Parametrii de fabricație M5 pot fi implementați chiar și pe mașini SLM mai vechi, limitate la 100 W puterea laserului, subliniind relevanța practică și impactul potențial asupra productivității.

Cosmin COSMA, Dr. Eng., Lecturer, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 400641 Cluj-Napoca, Romania, cosmin.cosma@tcm.utcluj.ro.

Stelian LIBU, Director of Digital Technology Department, Dental Design Lab, 18121 Athens, Greece

Alexandru POPAN, Dr. Eng., Associate professor, Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 400641 Cluj-Napoca, Romania.

Mircea DUDESCU, Prof. Dr. Eng., Technical University of Cluj-Napoca, Department of Mechanical Engineering, 400641 Cluj-Napoca Romania.

Nicolae BALC, Prof. Dr. Eng., Technical University of Cluj-Napoca, Department of Manufacturing Engineering, 400641 Cluj-Napoca, Romania.