e-ISSN: 2637-0611

Available online at
https://journal.uitm.edu.my/ojs/index.php/COS

Compendium of Oral Science 12 (2) 2025, 164 - 175

Compendium of Oral Science

Effect of Nano SiO_2 Treatment on Surface Roughness of Modified Acetal and Polyamide Thermoplastic Partial Denture Clasp Materials

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ARTICLE INFO

Article history:
Received 04 January 2024
Revised 13 April 2024
Accepted 13 August 2024
Online First
Published 01 September 2025

Keywords:
nano sio2 coating
thermoplastic partial denture clasp materials
non-touch profilometer surface texture
surface roughness

DOI:
10.24191/cos.v12i2.8841

ABSTRACT

Objectives: This in-vitro study aimed to investigate the effect of nano SiO_2 coating on the surface roughness of E. glass fibres reinforced acetal and polyamide thermoplastic resin partial denture clasp materials.

Materials and methods: 144 thermoplastic disk specimens were fabricated using two material groups, acetal (n=72) and polyamide (n=72). Each of these two material groups was further divided into three subgroups (n=24/subgroup), namely 1: unmodified (control), 2: internally E. glass fibres reinforced, and 3: externally nano SiO_2 coated with internally E. glass fibres reinforced. Alicona non-touch profilometer was used to measure the surface roughness of all test specimens.

Results: Control and E. glass fibres reinforced of acetal and polyamide resin subgroups showed the highest mean surface roughness; (Ra= 0.181 µm, 0.111µm) respectively. In the third subgroup, the acetal resin showed slightly higher surface roughness than the polyamide resin group; (Ra= 0.1114µm, 0.1113µm) respectively at (P=0.838).

Conclusion: Utilization of nano SiO_2 coating on acetal and polyamide thermoplastic partial denture clasp materials can significantly enhance their surface properties, resulting in improved surface roughness. This novel technique stands as a promising external approach for ameliorating the performance of these materials.

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1. INTRODUCTION

In recent years, there has been a discernible rise in the aesthetic demands of dental patients. In response to this growing trend, new dental materials such as flexible aesthetic clasps (Akl & Stendahl, 2022) and modifications of existing materials like thermoplastic resins (Zoidis et al., 2016) have been developed as alternative technical modalities for removable partial denture clasps. These consequently may fulfil dental patients' preferences and expectations while also promoting oral health standards (Song et al., 2019).

Thermoplastic resin gained this reputation as a preferred material for removable partial denture clasps due to superior aesthetics, non-allergenicity, favourable mechanics and comfortable experience (Takabayashi, 2010). Nevertheless, the characteristics of these substances continue to present significant obstacles to their clinical utilization and attainment of optimal efficacy. The limitations of thermoplastic resins include insufficient rigidity, water sorption, inferior colour stability and their surfaces are prone to be roughened by abrasive effects easily (Song et al., 2019).

The surface properties of thermoplastic resin clasps, especially their roughness which has a considerable significance impact on their performance and patient acceptance. Surface roughness plays a pivotal role in influencing critical factors such as bacterial colonization, plaque accumulation, tissue irritation, staining and the overall prognosis of the prosthesis. Thus, strategic optimization of surface roughness on thermoplastic partial denture clasps is crucial for their enduring success and promotes patient satisfaction in the field of removable prosthodontics (Rapone et al., 2022).

Although the great care is taken by both the technician and the dentist during the finishing and polishing steps of making a dental prosthesis, nevertheless a certain degree of surface roughness will persist. The inherent properties and the presence of the existing surface roughness of thermoplastic partial denture clasp materials after polishing are considered the contributing factors for the consequences of final surface roughness (Barbosa et al., 2005). A few in vivo studies proposed a surface roughness borderline for bacterial retention (Ra = 0.20 μm) (Park et al., 2019). Beneath this point, further reduction in bacterial clustering should not be expected (Bollenl et al., 1997), (Park et al., 2019) Various research trials suggested that the accumulation of plaque is anticipated to diminish on surfaces under this limit (Kuhar & Funduk, 2005), (Bollenl et al., 1997).

The concept of employing a secondary developed material to coat a substrate yields advantageous outcomes solely with regard to the material's external properties, while its internal characteristics remain unaltered (Wang et al., 2008). The practice of applying veneers to removable dental prostheses, utilizing materials such as acrylic resin, composite, and silica is a very famous technique for masking the undesirable aesthetic properties of metallic partial denture clasps (Wang et al., 2008), (Özcan, 2002).

The utilization of coatings material over the removable complete dentures presents a range of practical implications, including the enhancement of scratch resistance and hardness of the PMMA denture base material. This improvement is achieved through the incorporation of colloidal silica and polysiloxane as coating agents (Chantarachindawong et al., 2012), The anti-fungal properties of the heat-polymerized acrylic resin can be attributed to the incorporation of nano silicon dioxide, which effectively reduces the adhesion of candida albicans by minimizing the surface roughness of the material (Gad et al., 2022). Furthermore, the application of silica nanoparticles coating material resulted in significant improvements in the surface characteristics of the acrylic resin denture base material, particularly in the modification of their surface hydrophilicity (Azuma et al., 2012).

https://doi.org/10.24191/cos.v12i2.8841

Previous research on enhancing the characteristics of thermoplastic partial denture clasp materials through classical internal glass fibres reinforcement successfully ameliorates some properties such as compactness, rigidity and flexural strength. Yet failed to gain extrinsic factors attributed to aesthetic, hydrophobicity and surface roughness improvement (Nagakura et al., 2017). Therefore, this in vitro study aimed to investigate the effect of combining both the conventional internal glass fibers reinforcement and a novel external nano SiO2 coating on improving the surface texture of the two tested thermoplastic materials.

2. MATERIALS AND METHODS

2.2 Specimen preparation CRITERIA OF PULP CAPPING MATERIAL

144 thermoplastic resin disk-shaped specimens at a uniform size (φ 20 mm, 2.5 mm thick) were fabricated from acetal (Yunnan Co. LTD; China), (n = 72), and polyamide (Valplast, International corp.; USA), (n = 72). All specimens from both material groups were divided randomly into six subgroups (n = 24 for each subgroup). The first subgroup was without any modification, as a control group. The second subgroup was reinforced with 50 mass% of E. glass fibre, while the third subgroup was internally reinforced with 50 mass% of E. glass fibre and externally coated with nano SiO_2 coating material.

All the specimens were fabricated using a conventional injection moulding technique. Firstly, the mould was prepared using a wax pattern that was invested in plaster. Then, the control group which was without modification of the resins was injected into the mould and packed. Meanwhile, for subgroups 2 and 3, a mixture of each thermoplastic material singly and 50 mass% of E. glass fibre was prepared and packed into metallic cartridges. The metallic cartridges were then heated to plasticize the mixture which was injected into the mould using the injection moulding technique by an injection moulding machine (Vertex Thermoject 22; dental B.V Netherlands). The materials used and their recommended processing method are as in (Table 1).

Table 1. Materials used and their recommended processing method.

Material	Brand Name	Processing Method	Lot Number	Manufacturer
Acetal Polyoxy-Methylene (POM)	Zovgov	Heat processed at 220˚C for 20 min and injected under 4.0 MPa	Q/YTH 004-2019	Yunnan Co.Ltd, China
Polyamide Valplast (VA)	Flex star™	Heat processed at 288˚C for 11.20 min and injected under 1.0 MPa	Nobilium™-211038K10	CMP industries LLC., USA

2.3 Finishing and Polishing

All test specimens were finished using acrylic tungsten carbide bur to remove any nodules and irregularities, followed by final finishing using silicon carbide waterproof abrasive paper in successive grits of 280 and 600 for 10 seconds. Then, each specimen was polished from one surface by soft and superfine polishing brushes respectively for 30 seconds under dry condition using a handpiece (Kavo smart air plus; Germany) rotating at 10,000 rpm (Soares et al., 2019). The other surface of the specimen remains unpolished and each specimen was given a serial number which was written using a permanent pen on the unpolished surface to prevent multiple testing (Jang et al., 2015).

https://doi.org/10.24191/cos.v12i2.8841

2.4 Nano SiO_2 Coating

A very thin layer of silane coupling agent (Bis-silane™; Bisco, USA) was applied on the etched specimen surfaces of subgroup three of acetal and polyamide materials using (Bis-dark blue brush applicator; Bisco, USA), to promote the bonding between the specimen surfaces of the two tested materials and nano SiO_2 coating material (Matinlinna et al., 2018). These specimens were dipped for 20 seconds in a container containing nano SiO_2 liquid horizontally and they were arranged separately from each other and allowed to dry (Maleki Dizaj et al., 2023). Subsequently, the dried coating layer thickness was measured using a digital coating thickness gauge (HW-300S Vakind; China). Three measurements were made at three different locations for each specimen and the mean was calculated (Ng et al., 2021). The acceptable coating layer thickness' mean for all specimens was (50 ± 1μm).

2.5 Investigation of surface roughness

The surface roughness values for all test specimens were measured after storage in distilled water for 48 hours in an incubator (Binder-Germany) at 37°C for rehydration and completion of polymerization (Gad et al., 2022). Each test specimen was dried using paper tissues before testing (Kumavat et al., 2016). A non-touch surface texture profilometer (Alicona infinite focus real 3D; Grambach, Austria), was used to measure the surface roughness values of all test specimens (Patel & Kiran, 2020). The utilized parameters were x2 magnification with a vertical resolution of 336.1900 nm and lateral resolution of 2.9356 μm. The Ra (μm) values of each test specimen were measured at three different areas and the mean was calculated (Latif et al., 2019).

2.6 Statistical analysis:

The resulting surface roughness data were statistically analysed using SPSS software program version 27 (IBM Corp., Armonk - NY). Kolmogorov-Smirnov test showed normal distribution for all the values. One-way analysis of variance (ANOVA) was used to assess the mean difference in surface roughness within the subgroups' specimens for both acetal resin and polyamide resin respectively. Further (LSD) post hoc test was carried out to identify a significant difference in mean surface roughness between the six tested subgroups of acetal resin and polyamide resin. Independent sample t-test analysis was used to assess the difference in mean surface roughness between acetal nano SiO_2 coated with E. glass fibres reinforced and polyamide nano SiO_2 coated with E. glass fibres reinforced. The significant difference was set at ($P < 0.05$).

3. RESULTS

The one-way ANOVA results are summarized in Table 2 and illustrated in Figure 3 showing a significant difference in mean surface roughness between the three subgroups of each tested material: $F(2) = 2$, 20034.04, 6524.93, and ($P < 0.001$) respectively.

https://doi.org/10.24191/cos.v12i2.8841

Table 2. The mean and standard deviation of surface roughness (Ra) of the acetal resin and polyamide resin *

Material	Subgroups	Ra Mean in µm ± SD	F value	P value
Acetal resin	Control	0.181 ± 0.001	20034.04	< 0.001
	E. glass fibre reinforced	0.181 ± 0.001		
	Nano SiO_2 coated with E. glass fibre reinforced	0.111 ± 0.001		
Polyamide resin	Control	0.141 ± 0.000	6524.93	
	E. glass fibre reinforced	0.141 ± 0.000		
	Nano SiO_2 coated with E. glass fibre reinforced	0.111 ± 0.001		

Note: * One-way Anova test results

Within the acetal resin subgroups, the control group showed the highest mean surface roughness; (0.181 ± 0.001). However, the nano SiO_2 coated with E. glass fibres reinforced exhibited the lowest mean surface roughness; (0.111 ± 0.001). E. glass fibres reinforced subgroup and control subgroup showed the same surface roughness means; (0.181 ± 0.001).

Among the polyamide resin subgroups, the control group exhibited the highest mean surface roughness; (0.141 ± 0.000). Whereas the nano SiO_2 coated with E. glass fibres reinforced revealed the lowest mean surface roughness; (0.111 ± 0.001). E. glass fibres reinforced subgroup and control subgroup showed the same surface roughness means; (0.141 ± 0.000).

(LSD) post hoc test results are illustrated in Table 3 which was used to test the pairwise comparison of the three subgroups' means of each tested material respectively and found all the subgroups were significantly different (P < 0.001).

Table 3. Multiple comparison of acetal and polyamide resins*

Material	Subgroups		(Ra) Mean Difference in µm	P-Value	95% Confidence Interval
Acetal	Nano SiO_2 coated with E. glass fibre reinforced	Control	-0.069292	< 0.001	-0.070-(-0.068)
		E. glass fibre reinforced	-0.069292	< 0.001	-0.070-(-0.068)
Polyamide	Nano SiO_2 coated with E. glass fibre reinforced	Control	-0.029750	< 0.001	-0.030-(-0.029)
		E. glass fibre reinforced	-0.029750	< 0.001	-0.030-(-0.029)

Note: * (LSD) post hoc test shows mean difference between tested subgroups.

The Independent sample t-test results are outlined in Table 4 indicating no significant difference in the mean surface roughness between nano SiO_2 coated with E. glass fibres reinforced acetal resin and polyamide resin at (P = 0.838). Between the two tested materials, acetal resin nano SiO_2 coated with E. glass fibres reinforced subgroup showed slightly higher mean surface roughness; (0.1114 ± 0.002) than polyamide resin nano SiO_2 coated with E. glass fibres reinforced subgroup; (0.1113 ± 0.001). However, the

https://doi.org/10.24191/cos.v12i2.8841

difference was very small measuring about 0.0001 which can be negligible. The surface topography and the mean surface roughness of acetal and polyamide resin subgroups are showed in (Figures 1 and 2).

Table 4. The differences in mean surface roughness of the nano SiO_2 coated with E. glass fibers reinforced between acetal and polyamide resins*.

Type of material	Ra Mean in µm ± SD	t-stats	P-value
Acetal resin nano SiO_2 coated with E. glass fibers reinforced	0.1114 ± 0.002	0.206	0.838
Polyamide resin nano SiO_2 coated with E. glass fibers reinforced	0.1113 ± 0.001		

Note: * Independent sample t-test results, $P < 0.05$

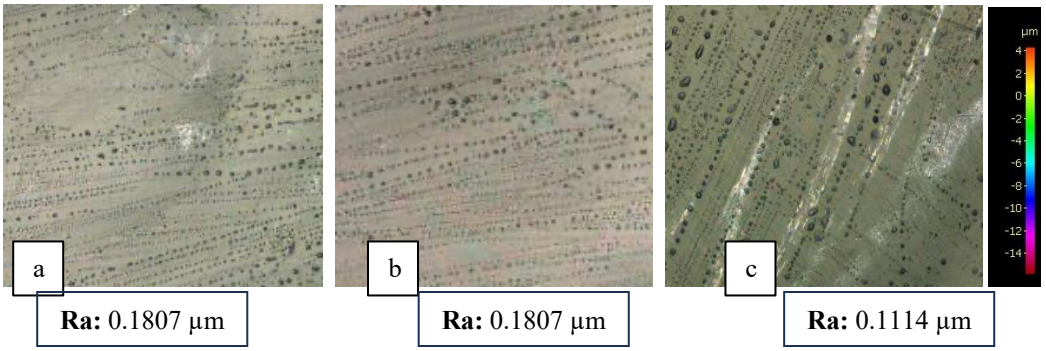

Fig. 1. Surface topography and mean surface roughness of acetal resin (a- control, b- E. glass fibres reinforced, c- nano SiO_2 coated with E. glass fibres reinforced).

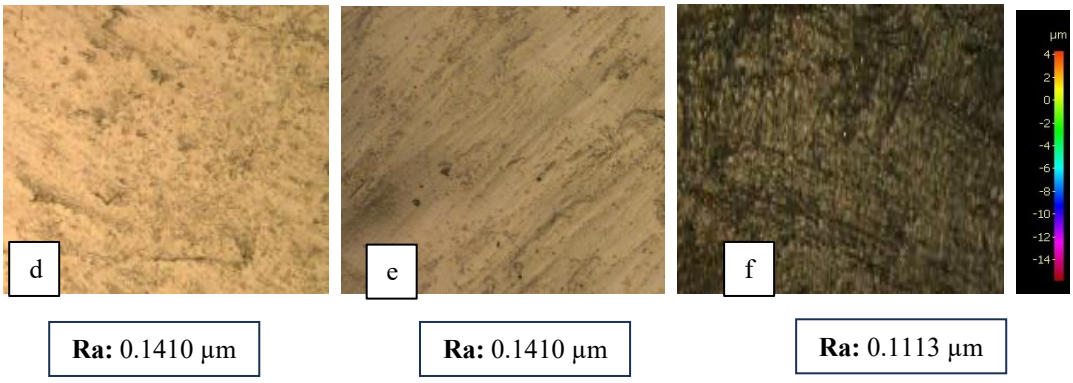

Fig. 2. Surface topography and mean surface roughness of polyamide resin (d- control, e- E. glass fibres reinforced, f- nano SiO_2 coated with E. glass fibres reinforced).

https://doi.org/10.24191/cos.v12i2.8841

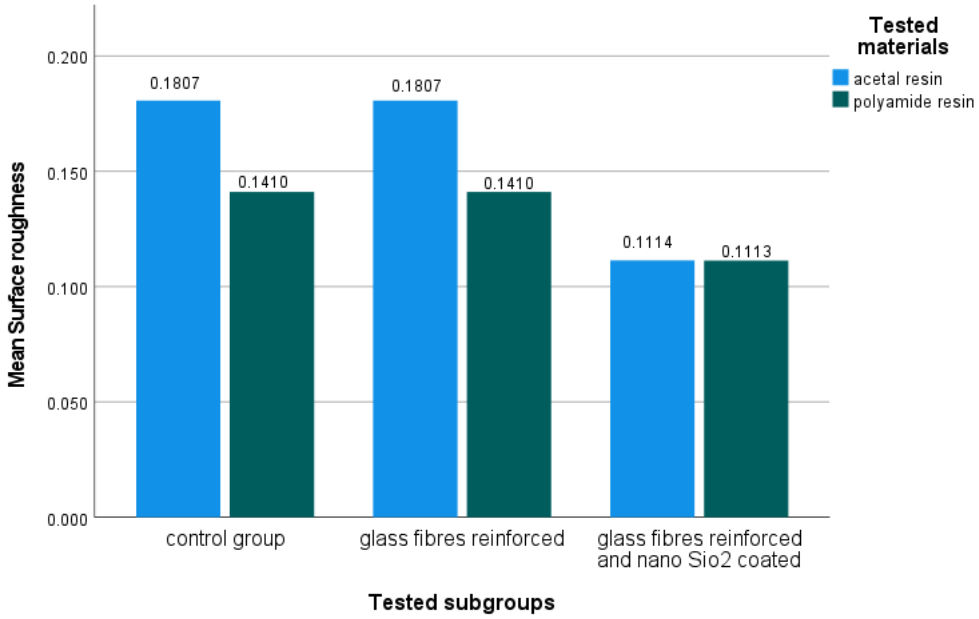

Fig. 3. Mean surface roughness of all tested subgroups

4. DISCUSSION

This study investigated the surface roughness (Ra) of non-reinforced, E. glass fibres reinforced, and nano SiO_2 coated with E. glass fibres reinforced acetal and polyamide resins. Non-touch profilometer which is a precise, effective, and powerful tool (Patel & Kiran, 2020) was used to assess the surface roughness on all test specimens, which augments the reliability and validates the accuracy of the testing procedure.

The surface roughness of dental prosthesis materials is mostly affected by basic material properties, polishing methods, and the operator's technical proficiency (Rapone et al., 2022). In this study, all samples were prepared using the same batch of the two tested materials respectively in order to standardise the specimen's preparation process and avoiding any variations. A suitable cartridge containing a sufficient amount of each tested material mixture was used to prevent material insufficiency and the formation of specimens defects which usefully affected the surface profile of the tested specimens (S El-Din et al., 2018).

Injection moulding technique was used to process the specimens of the two tested materials which was practically proven to produce superior quality dental prosthesis surfaces in comparison with the conventional technique (Chuchulska et al., 2022). Therefore, the resulting surface roughness accurately represents the true surface texture of the acetal and polyamide resins, devoid of any interference caused by processing-related errors which strengthens the efficiency of the testing procedure.

Previous literature indicated the effectiveness of silane coupling agents in enhancing the surface properties of dental appliances (Moffa et al., 1975), (Nihei et al., 2008), (Matinlinna & Lassila, 2011). In this study silane coupling material performed an important complementary function in achieving the nano SiO_2 coating by ensuring the linkage of the coating material with the underlying acetal and polyamide resins

https://doi.org/10.24191/cos.v12i2.8841

(Yodmongkol et al., 2014). This facilitates the nano SiO_2 spread which produces a homogeneous smooth coating film in comparison with non-coated subgroups.

The specimens of the two nano SiO_2 coated subgroups of the two tested materials were coated using the dip coating technique which provided outstanding coating spread quality. This can be ascribed to the dip coating technique permitting a remarkable spread of sufficient nano SiO_2 coating material amount over a wide surface area devoid of any agglomerations or irregularities (Kamonwanon et al., 2017), (Yodmongkol et al., 2014). In the present study, the dip coating technique eased the formation of the notable nano SiO_2 coating layer for the acetal and polyamide specimens which could be considered as evidence of the efficacy of the coating technique.

In the present study, it was found that E. glass fibres reinforced and control polyamide subgroups showed better surface texture in comparison with E. glass fibres reinforced and control acetal subgroups which can be due to inherent material properties, as in agreement with (Mekkawy et al., 2015).

Various methods can be employed to enhance or optimize the surface texture quality of removable dental prostheses, such as ideal laboratory polishing and appropriate surface coating. These methods can produce a smooth and lustrous prosthesis surface (Kovoor & Attavar, 2023), (AlBin-Ameer et al., 2020). In this study, all specimens were finished and polished with the same technique using standard time, pressure and speed to produce consistent polishing quality and to prevent any dissimilarity (S El-Din et al., 2018). Based on the results of this study, it is obvious that the ideal polishing technique was not enough to gain the optimal surface smoothness in comparison with the synergically effect of both ideal laboratory polishing and coating layer performance.

Nano SiO_2 coated externally with E. glass fibres-reinforced internally polyamide and acetal resin specimens exhibited the lowest mean surface roughness, each. Their surface textures are slick and smoother than the surfaces of other subgroups (E. glass fibres reinforced and control specimens) from both tested materials which are found irregular and rougher. This is due formation of a smooth glassy layer as a result of nano SiO_2 coating which in turn could be considered as evidence on its' efficiency as a coating material for aesthetic clasps. These results are in agreement with (AlBin-Ameer et al., 2020).

Taking into consideration the difference in material composition, E. glass fibres reinforced subgroups and control subgroups of acetal and polyamide respectively displayed identical surface roughness figures. This could be ascribed to glass fibres of the two reinforced subgroups are embedded inside the resin matrix of the two tested materials (Tanimoto & Nagakura, 2018) which makes the addition of the reinforcing glass fibres have no impact on the surface properties, thus making them have similar degree of surface roughness with control subgroups.

The limitations of this study include using a single type of polishing technique for the tested specimens which is mechanical polishing. Therefore, further investigations using combination of mechanical and chemical polishing are recommended to investigate the effect of various polishing technique on the materials. In addition, it was difficult to compare the surface roughness results of this study with other studies owing to the materials used, novel coating approach and finite literature studies.

5. CONCLUSION

According to study findings and within the limitations of this study, it can be concluded that Nano SiO_2 coating has significantly reduced the surface roughness of acetal and polyamide resin specimens compared to non-coated specimens of the same materials. Coating thermoplastic resin clasp materials using nano SiO_2

https://doi.org/10.24191/cos.v12i2.8841

is practically effective with respect to improving the surface texture properties below the clinically desirable threshold (Ra = 0.20μm), preventing accumulation and retention of oral microorganisms, and therefore improves their cleanliness and oral health.

ACKNOWLEDGEMENTS/FUNDING

The authors would like to acknowledge the support of the Ministry of Higher Education and Scientific Research in Libya (University of Tripoli), Faculty of Dentistry (Universiti Teknologi MARA) Shah Alam, Selangor, Malaysia for providing the facilities and financial support for this research, and Faculty of Dentistry (Universiti MALAYA) Kuala Lumpur, Malaysia for providing the technical equipment for the research.

CONFLICT OF INTEREST STATEMENT

We declare neither financial nor personal relationships that could influence the work reported in this paper.

AUTHORS' CONTRIBUTIONS

Ayoub Zabida conceptualised the central research idea, provided the theoretical framework, carried out the research and laboratory work, wrote, and revised the article. **Mohamed Ibrahim Abu Hassan, Hazlina Abdul Ghani,** and **Nor Wati Nur Atikah Mustafa** designed the research, supervised the research work, edited, and approved the article submission.

REFERENCES

AlBin-Ameer, M. A., Alsrheed, M. Y., Aldukhi, I. A., Matin, A., Khan, S. Q., Abualsaud, R., & Gad, M. M. (2020). Effect of protective coating on surface properties and Candida albicans adhesion to denture base materials. *Journal of Prosthodontics, 29*(1), 80-86. https://doi.org/10.1111/jopr.13118.

Azuma, A., Akiba, N., & Minakuchi, S. (2012). Hydrophilic surface modification of acrylic denture base material by silica coating and its influence on Candida albicans adherence. *Journal of medical and dental sciences, 59*(1), 1-7.

Barbosa, S. H., Zanata, R. L., Navarro, M. F. d. L., & Nunes, O. B. (2005). Effect of different finishing and polishing techniques on the surface roughness of microfilled, hybrid and packable composite resins. *Brazilian Dental Journal, 16*(1), 39-44. https://doi.org/10.1590/s0103-64402005000100007.

Bollenl, C. M., Lambrechts, P., & Quirynen, M. (1997). Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. *Dental materials, 13*(4), 258-269. https://doi.org/10.1016/s0109-5641(97)80038-3.

Chantarachindawong, R., Luangtip, W., Chindaudom, P., Osotchan, T., & Srikhirin, T. (2012). Development of the scratch resistance on acrylic sheet with basic colloidal silica (SiO2)—methyltrimethoxysilane (MTMS) nanocomposite films by sol–gel technique. *The Canadian Journal of Chemical Engineering, 90*(4), 888-896. https://doi.org/10.1002/cjce.21631.

Chuchulska, B., Hristov, I., Dochev, B., & Raychev, R. (2022). Changes in the Surface Texture of Thermoplastic (Monomer-Free) Dental Materials Due to Some Minor Alterations in the Laboratory Protocol—Preliminary Study. *Materials, 15*(19), 6633. https://doi.org/10.3390/ma15196633.

Gad, M. M., Bahgat, H. A., Edrees, M. F., Alhumaidan, A., Khan, S. Q., & Ayad, N. M. (2022). Antifungal activities and some surface characteristics of denture soft liners containing silicon dioxide nanoparticles. *Journal of International Society of Preventive & Community Dentistry, 12*(1), 109-116. https://doi.org/10.4103/jispcd.JISPCD_286_21.

Jang, D.-E., Lee, J.-Y., Jang, H.-S., Lee, J.-J., & Son, M.-K. (2015). Color stability, water sorption and cytotoxicity of thermoplastic acrylic resin for non metal clasp denture. *The journal of advanced prosthodontics, 7*(4), 278-287. https://doi.org/10.4047/jap.2015.7.4.278.

Kamonwanon, P., Hirose, N., Yamaguchi, S., Sasaki, J.-i., Kitagawa, H., Kitagawa, R., Thaweboon, S., Srikhirin, T., & Imazato, S. (2017). SiO2-nanocomposite film coating of CAD/CAM composite resin blocks improves surface hardness and reduces susceptibility to bacterial adhesion. *Dental materials journal, 36*(1), 88-94. https://doi.org/10.4012/dmj.2016-135.

Kovoor, K. L., & Attavar, S. H. (2023). Comparative evaluation of the surface roughness of a microhybrid and nanohybrid composites using various polishing system: A profilometric analysis. *Journal of International Oral Health, 15*(4), 372.

Kuhar, M., & Funduk, N. (2005). Effects of polishing techniques on the surface roughness of acrylic denture base resins. The Journal of prosthetic dentistry, 93(1), 76-85. https://doi.org/10.1016/j.prosdent.2004.10.002.

Kumavat, V., Raghvendra, S. S., Vyavahare, N., Khare, U., & Kotadia, P. (2016). Effect of alcoholic and non-alcoholic beverages on color stability, surface roughness and fracture toughness of resin composites: an in vitro study. *IIOAB J, 7*(6), 48-54.

Latif, N. A., Kasolang, S., Ahmad, M., & Bakar, M. (2019). Effect of oleophilicity on Pistia inspired surface roughness. *Journal of Mechanical Engineering, 8*(1), 105-116.

Maleki Dizaj, S., Torab, A., Kouhkani, S., Sharifi, S., Negahdari, R., Bohlouli, S., Fattahi, S., & Salatin, S. (2023). Gelatin–Curcumin Nanocomposites as a Coating for Implant Healing Abutment: In Vitro Stability Investigation. *Clinics and Practice, 13*(1), 88-101. https://doi.org/10.3390/clinpract13010009.

Matinlinna, J. P., & Lassila, L. V. (2011). Enhanced resin-composite bonding to zirconia framework after pretreatment with selected silane monomers. *Dental materials, 27*(3), 273-280. https://doi.org/10.1016/j.dental.2010.11.002.

Matinlinna, J. P., Lung, C. Y. K., & Tsoi, J. K. H. (2018). Silane adhesion mechanism in dental applications and surface treatments: A review. *Dental materials, 34*(1), 13-28. https://doi.org/10.1016/j.dental.2017.09.002.

Mekkawy, M. A., Hussein, L. A., & Alsharawy, M. A. (2015). Comparative study of surface roughness between polyamide, thermoplastic polymethyl methacrylate and acetal resins flexible denture base materials before and after polishing. *Life Science Journal, 12*(10), 90-95.

Moffa, J. P., Jenkins, W. A., & Weaver, R. G. (1975). Silane bonding of porcelain denture teeth to acrylic resin denture bases. *The Journal of prosthetic dentistry, 33*(6), 620-627. https://doi.org/10.1016/s0022-3913(75)80123-5.

Nagakura, M., Tanimoto, Y., & Nishiyama, N. (2017). Fabrication and physical properties of glass-fiber-reinforced thermoplastics for non-metal-clasp dentures. *Journal of Biomedical Materials Research Part B: Applied Biomaterials, 105*(8), 2254-2260. https://doi.org/10.1002/jbm.b.33761.

Ng, Y. H., Dasari, A., Tan, K. H., & Qian, L. (2021). Intumescent fire-retardant acrylic coatings: Effects of additive loading ratio and scale of testing. *Progress in Organic Coatings, 150*, 105985. https://doi.org/10.1016/j.porgcoat.2020.105985.

Nihei, T., Dabanoglu, A., Teranaka, T., Kurata, S., Ohashi, K., Kondo, Y., Yoshino, N., Hickel, R., & Kunzelmann, K.-H. (2008). Three-body-wear resistance of the experimental composites containing filler treated with hydrophobic silane coupling agents. *Dental materials, 24*(6), 760-764. https://doi.org/10.1016/j.dental.2007.09.001.

Özcan, M. (2002). The use of chairside silica coating for different dental applications: a clinical report. The *Journal of prosthetic dentistry, 87*(5), 469-472. https://doi.org/10.1067/mpr.2002.124365.

Park, J.-W., An, J.-S., Lim, W. H., Lim, B.-S., & Ahn, S.-J. (2019). Microbial changes in biofilms on composite resins with different surface roughness: An in vitro study with a multispecies biofilm model. *The Journal of prosthetic dentistry, 122*(5), 493. e491-493. e498. https://doi.org/10.1016/j.prosdent.2019.08.009.

Patel, D. R., & Kiran, M. (2020). A non-contact approach for surface roughness prediction in CNC turning using a linear regression model. *Materials Today: Proceedings, 26*, 350-355. https://doi.org/10.1016/j.matpr.2019.12.029.

Rapone, B., Pedone, S., Carnevale, A., Plantamura, P., Scarano, A., Demelio, A., Demelio, G. P., & Corsalini, M. (2022). Profilometer comparison of the surface roughness of four denture base resins: An In Vitro study. *Applied Sciences, 12*(4), 1837. https://doi.org/10.3390/app12041837.

S El-Din, M., Badr, A. M., Agamy, E. M., & Mohamed, G. F. (2018). Effect of two polishing techniques on surface roughness of three different denture base materials (an in vitro study). *Alexandria Dental Journal, 43*(3), 34-40. https://doi.org/10.21608/adjalexu.2018.57990.

Soares, I. A., Leite, P. K. B. d. S., Farias, O. R., Lemos, G. A., Batista, A. U. D., & Montenegro, R. V. (2019). Polishing methods' influence on color stability and roughness of 2 provisional prosthodontic materials. *Journal of Prosthodontics, 28*(5), 564-571. https://doi.org/10.1111/jopr.13062.

Song, S.-Y., Kim, K.-S., Lee, J.-Y., & Shin, S.-W. (2019). Physical properties and color stability of injection-molded thermoplastic denture base resins. *The journal of advanced prosthodontics, 11*(1), 32-40. https://doi.org/10.4047/jap.2019.11.1.32.

Takabayashi, Y. (2010). Characteristics of denture thermoplastic resins for non-metal clasp dentures. *Dental materials journal, 29*(4), 353-361. https://doi.org/10.4012/dmj.2009-114.

Tanimoto, Y., & Nagakura, M. (2018). Effects of polishing on surface roughness and hardness of glass-fiber-reinforced polypropylene. *Dental materials journal, 37*(6), 1017-1022. https://doi.org/10.4012/dmj.2018-012.

Wang, L., Zhao, W., & Tan, W. (2008). Bioconjugated silica nanoparticles: development and applications. *Nano Research, 1*, 99-115.

Yodmongkol, S., Chantarachindawong, R., Thaweboon, S., Thaweboon, B., Amornsakchai, T., & Srikhirin, T. (2014). The effects of silane-SiO2 nanocomposite films on Candida albicans adhesion and the surface and physical properties of acrylic resin denture base material. The Journal of prosthetic dentistry, 112(6), 1530-1538. https://doi.org/10.1016/j.prosdent.2014.06.019.

6. APPENDIX

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