

CERAMIC-FILLED COMPOSITE RESINS, AN ADVANCED SOLUTION FOR AESTHETICALLY PLEASING AND DURABLE TEMPORARY PROSTHETIC WORKS

Kamel Earar¹, Norina Consuela Forna^{2*}, Dorin Ioan Cocos^{1*}, Viorica Chetrus³, Irina Adriana Beuran⁴, Marius Vacaru Carnaru¹, Ovidiu Sebastian Nicolaiciuc²

¹ Faculty of Medicine and Pharmacy, University "Dunarea de Jos" Galati, Romania

² "Grigore T. Popa" University of Medicine and Pharmacy, Iasi, Romania

³ Faculty of Stomatology, Nicolae Testemitanu State University of Medicine and Pharmacy, Chisinau, Republic of Moldova

⁴ Carol Davila University of Medicine and Pharmacy, Bucuresti, Romania

*Corresponding authors: norina_forna@yahoo.com, cdorin1123@gmail.com

All authors have the same contribution.

Abstract

Ceramic-filled composite resins are an advanced solution in temporary prosthetics, combining outstanding aesthetics with superior mechanical properties. These hybrid materials are frequently used for temporary crowns and bridges due to their wear resistance and ability to faithfully mimic natural dental structures. Their compatibility with CAD/CAM technologies allows the work to be carried out quickly and accurately, reducing treatment time and increasing patient satisfaction. Although the higher costs and complexity of the application technique can be challenging, the benefits offered outweigh the limitations. Recent research has focused on improving antimicrobial properties and long-term stability, highlighting the potential of these materials to transform dental practice. In conclusion, ceramic-filled composite resins are a modern standard in dental prosthetics, offering aesthetic, durable and effective solutions for temporary restorations.

Keywords: Composite resins, ceramic filler, temporary prosthetics, dental aesthetics, CAD/CAM technologies, temporary restorations, biomaterial innovations.

Introduction

The materials used in temporary dental prosthetics play an essential role in ensuring patient comfort and maintaining oral functions until the final work is completed. Temporary restorations not only protect the prepared dental structures, but also offer the possibility of aesthetic and functional evaluation before the final restoration. In this context, ceramic-filled composite resins have gained significant popularity due to their ability to combine outstanding aesthetics with superior mechanical properties. These innovative materials represent a significant evolution over conventional acrylic resins, which, while easy to use and affordable, have

limitations in terms of durability and long-term aesthetics [1-3].

Technological progress in recent decades has allowed the integration of ceramic particles into the matrix of composite resins, resulting in hybrid materials that offer a unique combination of strength and natural appearance. This combination is essential in modern prosthetics, where the aesthetic requirements of patients are increasing. In addition, these hybrid materials adapt better to occlusal and abrasive stresses in the oral cavity, ensuring superior performance compared to traditional materials. The development of ceramic-filled composite resins was also driven by

the need to create temporary restorations that would better withstand environmental factors, such as humidity and temperature variations, without compromising aesthetics or structural integrity [1-5].

Beyond functional considerations, the aesthetic aspect plays a central role in the choice of materials for temporary works. Ceramic-filled composite resins offer outstanding translucency and mimicry of natural tooth structures, making them ideal for patients who place a strong emphasis on aesthetics, especially in the frontal area. Color stability is another major advantage of these materials, helping to maintain a pleasing appearance during their temporary use. This feature is essential for patients who want to avoid the fading or hue changes commonly encountered with simpler materials [2-6].

Another reason supporting the adoption of ceramic-filled composite resins is their compatibility with modern technologies such as CAD/CAM systems. These technologies allow for fast and accurate execution of temporary work, reducing treatment time and providing high-quality personalized restorations. In this context, hybrid composite resins align perfectly with the current requirements of digital dentistry, being preferred by both practitioners and patients [1,3-6].

Ceramic-filled composite resins are an advanced solution that combines technological innovation with the aesthetic and functional requirements of modern patients. These materials have quickly become a standard in temporary prosthetics, redefining the way temporary works are approached and demonstrating the continued potential of biomaterials to transform dental practice [4-8].

Properties of hybrid materials

Ceramic-filled composite resins are distinguished by a complex set of properties that give them a distinct advantage in use for temporary prosthetic works. Their hybrid composition is a combination of an organic resin matrix and inorganic ceramic particles, which ensures superior mechanical and aesthetic performance. This innovative combination not only provides a material with increased strength, but also allows excellent adaptation to the aesthetic requirements of the oral area. The types of ceramic particles used in these materials vary in size and composition, including nanoparticles and microparticles that optimize the overall properties of the material. The small size and uniform distribution of these particles contribute to improving wear resistance and translucency, which are critical for temporary restorations in esthetic areas [4-8].

An essential aspect of these materials is their superior mechanical properties. The abrasion and wear resistance is significantly higher compared to traditional materials, making them suitable for use in areas that withstand increased occlusal forces. The elastic modulus of ceramic-filled composite resins is optimized to provide a combination of flexibility and rigidity, ensuring perfect adaptation to the mechanical stresses of the oral cavity. These materials also exhibit good resistance to cracking and fracturing, essential characteristics for temporary work that must withstand mechanical stress over longer periods [2,4-8].

In addition to mechanical characteristics, the aesthetic properties of ceramic-filled composite resins make them

a preferred choice in temporary restorations. The translucency of these materials faithfully mimics the appearance of natural enamel, providing a remarkable aesthetic integration into the oral cavity. This is complemented by the material's ability to accurately reproduce dental nuances, ensuring personalized aesthetics for each patient. Moreover, long-term color stability is another major advantage, helping to maintain a pleasant and natural appearance during use. Unlike traditional materials, which can undergo discoloration or hue changes in a moist oral environment, hybrid composite resins are designed to withstand external factors such as temperature variations and exposure to colored foods and beverages [5-9].

Another important advantage is the easy handling of these materials. They are easy to shape and can be light-cured quickly, significantly reducing the time required to carry out temporary works. Also, compatibility with modern dental adhesives ensures a secure and effective fixation, contributing to the stability of temporary restorations. These characteristics make ceramic-filled composite resins an ideal solution for both dentists and patients, due to the optimal combination of mechanical performance, superior aesthetics and ease of use. Therefore, these materials are a modern and versatile choice in temporary dental prosthetics [5-9].

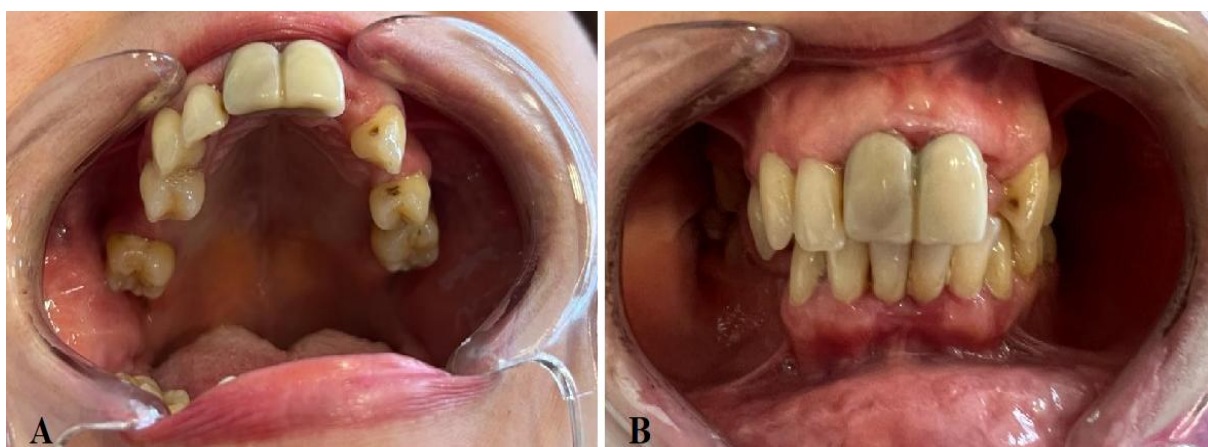


Figure 1. The appearance of the oral cavity before prosthetic rehabilitation. Images A and B highlight significant tooth loss and compromised tooth structures.

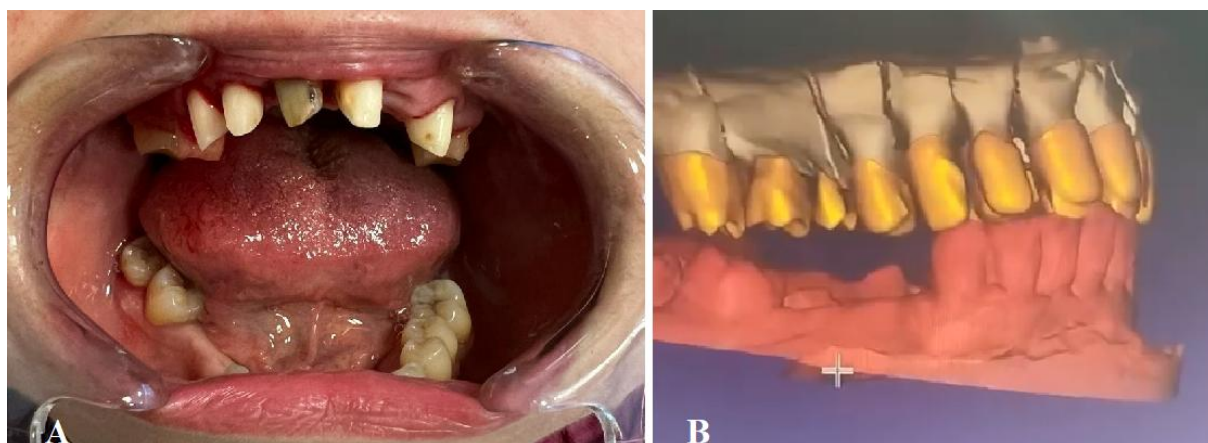


Figure 2. Image A shows the preparation of the prosthetic field by preparing the dental elements. Image B highlights the digital model created by intraoral scanning, used for the planning of prosthetic treatment, facilitating a personalized and accurate reconstruction, which integrates the aesthetics and functionality of dental restoration.

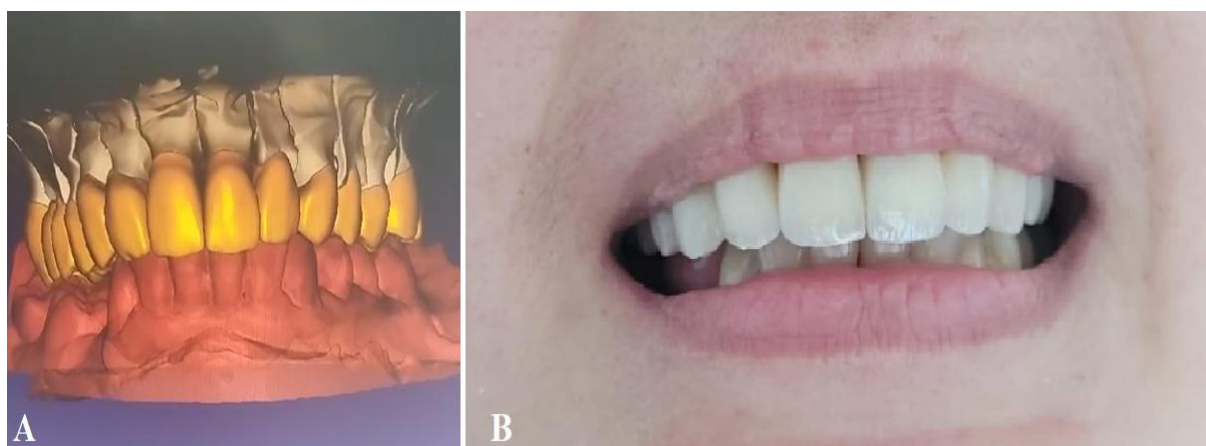


Figure 3. Stages of oral rehabilitation: Image A shows the digital model made by CAD/CAM technology for dental restoration planning. Image B highlights the final result, with a temporary dental prosthesis, restoring the aesthetics of the smile and optimal functionality, contributing to improving the patient's quality of life.

Advantages of using ceramic filler composite resins

Ceramic-filled composite resins offer a number of advantages that make them stand out as an ideal option for temporary prosthetic work. One of the main benefits is the superior mechanical strength that these materials provide. The integration of ceramic particles into the resin matrix contributes to increasing the durability of the material, making it more resistant to occlusal forces and wear. This is especially important for patients who need temporary restorations in areas with high mechanical stress, such as molars or premolars. Compared to traditional acrylic resins, hybrid composites are less prone to cracking or fracturing, thus ensuring greater long-term stability [7-11].

Another important advantage is their aesthetic adaptability. These materials have been developed to faithfully

reproduce the natural appearance of teeth, thanks to their translucency similar to enamel. This feature makes them ideal for temporary work in the front area, where aesthetics play a crucial role. Moreover, the color stability is remarkable, which means that restorations made of ceramic-filled composite resins retain their pleasant appearance throughout their use, without the risk of fading or shade changes. This represents a significant improvement over older materials, which were often affected by exposure to food, drink, or conditions in the oral cavity [4,7-11].

In addition to mechanical strength and superior aesthetics, another major advantage of these materials is their ease of handling. Ceramic-filled composite resins are easy to mold, allowing for precise and personalized temporary restorations for each patient. In addition, they can be light-cured quickly, significantly reducing the

time required for treatment. This is beneficial for both physicians, who can work efficiently, and patients, who benefit from a more comfortable and faster experience [4,8-12].

Also, the compatibility of these materials with modern dental adhesives is another strength. This allows for a secure and stable fixation of the temporary works, ensuring that they remain in place until they are replaced with the final restorations. This feature increases the confidence of both patients and physicians in the use of hybrid composite resins. Moreover, these materials are suitable for a

wide range of applications, from single-tooth crowns to complex temporary bridges, making them extremely versatile [8-12].

Ceramic-filled composite resins offer a unique combination of strength, aesthetics and ease of use, which places them at the top of the options for temporary prosthetic works. They represent an advanced solution, adapted to the modern requirements of patients and doctors, demonstrating their value through exceptional performance in various clinical situations [8,10-14].

Aspect	Description	Benefits	Challenges
Use in clinical applications	Ceramic-filled composite resins are frequently used to make single-tooth crowns, temporary bridges, and other temporary restorations. They offer aesthetic and functional solutions for various types of patients.	It allows for quick and aesthetic temporary treatments, protecting the prepared dental structures.	Technical complexity of use in complex clinical cases.
Specific indications	These materials are ideal for patients with high aesthetic requirements, especially for restorations in the frontal area. They are also suitable for complex temporary work, due to their durability and superior aesthetics.	It offers outstanding aesthetic results, with an excellent adaptation in the visible areas of the oral cavity.	The need for a high level of aesthetic preparation, especially for the frontal area.
Adhesive compatibility	These resins are compatible with most modern adhesives, which ensures a secure and stable hold. This is an essential feature for temporary work that requires medium to long-term retention.	Efficient fastening and stability, preventing the displacement of temporary works.	Possibility of limited interactions with certain traditional adhesives.
Adaptability to modern technologies	They are fully compatible with CAD/CAM technologies, allowing for fast and accurate restorations. Integration with these technologies makes treatments more effective and personalized.	Reduction of treatment time and customization of restorations according to patient requirements.	High costs associated with the necessary CAD/CAM equipment.
Recent innovations	Recent research has focused on improving the mechanical and aesthetic properties of materials, including the use of nanoparticles for increased performance. Materials with antimicrobial properties are another important development direction.	Improved properties such as wear resistance and long-term aesthetics.	Difficulties in integrating new innovations into everyday practice.

Future prospects	In the future, a deeper integration of materials with digital systems is planned, for a perfect adaptation to the needs of patients. The development of new hybrid materials, with superior performance, is a priority objective.	Transforming dental practice by increasing the efficiency and quality of temporary treatments.	Dependence on advanced technologies and the costs associated with them.
-------------------------	---	--	---

Table 2. The table provides a detailed analysis of ceramic-filled composite resins used in temporary prosthetics. It highlights aspects such as clinical use, benefits, challenges, and recent innovations, providing a comprehensive perspective on the future applications and developments of these modern materials [4,6,8-14].

Limitations and challenges of using ceramic-filled composite resins

Although ceramic-filled composite resins offer numerous benefits and are a modern solution for temporary prosthetic works, they are not without limitations and challenges. One of the main difficulties associated with the use of these materials is their sensitivity to the application technique. To achieve the desired results,

careful preparation and precise application are required, as any deviation from the recommended protocol can compromise both the aesthetics and performance of the restoration. For example, the uniform distribution of the material during modeling and light curing is essential to prevent the occurrence of internal stresses or defects that could lead to cracking [8-15].

Category	Materials	Properties
Resin matrix	Bis-GMA, UDMA, TEGDMA	High viscosity, flexible, viscosity control
Particulate filler	Zirconia, Silica, HA, Prepolymerized powders	High strength, biocompatibility, translucency, stability
Fibrous filler	Ceramic fibers, Glass fibers, Nanotubes, Polymer nanofibers	Mechanical strength, toughness, rigidity, antimicrobial
Novel shaped filler	Porous particles, Nanoclusters, Tetrapod whiskers, Core-sheath, Microcapsules	Surface area increase, uniform distribution, flexibility, controlled release
Initiating system	Photopolymerization, Self-curing	UV polymerization, chemical polymerization

Table 1. This table presents the compact classification of ceramic-filled composite resins, including the main categories, materials used and their essential properties. Characteristics such as biocompatibility, mechanical strength, stability and polymerization methods are highlighted, essential for optimizing the clinical performance and durability of dental restorations [6,14-24].

Another important aspect to consider is the higher cost of ceramic-filled composite resins compared to traditional materials such as acrylic resins. The higher price can be a barrier for some patients or clinics who want to limit the costs of

treatment. Also, the complexity of the manufacturing process and the advanced technology required to produce these materials contribute to their higher prices, which can limit their accessibility,

especially in smaller practices or areas with limited resources [8,18-24].

The long-term performance of these materials in the wet oral environment is another challenge. Although ceramic-filled composite resins are designed to withstand conditions in the oral cavity, including variations in temperature and humidity, their use for long periods can lead to wear and tear or loss of aesthetic properties, especially if the instructions for use are not followed or if patients do not follow the maintenance recommendations. Continuous exposure to occlusal forces and abrasion during chewing can cause microcracks or wear of ceramic particles, affecting the overall performance of the material [19-24].

Ceramic-filled composite resins are an advanced solution for aesthetic and resistant temporary prosthetic works, offering excellent adaptation and increased durability. Integrating essential oils with antimicrobial and anti-inflammatory properties, such as tea tree or eucalyptus, can improve biocompatibility and oral hygiene, reducing the risk of gum inflammation. These oils can be incorporated into adhesives or finishing materials to support peri-implant health. The combination of advanced technology with natural therapies optimizes treatments, providing patients with aesthetic, functional and beneficial solutions for long-term oral health [25-29].

Ceramic-filled composite resins offer aesthetic and resistant solutions for temporary prosthetic works, including in complex cases of dental inclusions, such as wisdom teeth. These materials allow for stable temporary restorations after difficult extractions, protecting adjacent structures and maintaining occlusal functionality. In

situations where impacted wisdom teeth affect tooth alignment, using these resins in temporary devices helps stabilize the arches. Their high adaptability and compatibility with CAD/CAM technologies facilitate personalized treatments, contributing to effective recovery and maintenance of dental integrity [30-41].

Ceramic-filled composite resins, used for temporary prosthetic work, benefit from the integration of advanced biomaterials, improving both aesthetics and durability. Bioactive biomaterials, such as those with ceramic nanoparticles or antimicrobial properties, increase mechanical strength and protect oral tissues. In addition, the use of resorbable or controlled-release materials of therapeutic agents can accelerate postoperative healing and reduce inflammation. The development of these biomaterials allows personalized treatments, adapted to the needs of each patient, strengthening prosthetic integration and long-term functionality in modern clinical practice [42-53].

Another disadvantage is the difficulty in repairing these materials in case of minor defects. Compared to simple resins, where repairs can be carried out relatively easily, ceramic-filled composite resins require additional surface preparation and the use of special materials to ensure proper adhesion. This complexity can prolong treatment time and increase costs for the patient [54-56].

Additionally, handling these materials may require specific equipment and tools, such as high-performance curing lamps and compatible adhesives, which can pose a challenge for dental practices that do not have these resources. Also, for

dentists, the optimal use of these materials requires a thorough understanding of their characteristics as well as hands-on experience in handling them, which may imply a longer learning curve for those who are not familiar with these types of restorations [16,54-57].

Although ceramic-filled composite resins bring numerous benefits in the practice of temporary prosthetics, they are not without limitations. Higher costs, sensitivity to the application technique, challenges in long-term use and the complexity of repairs are aspects that must be taken into account by both doctors and patients. However, by adopting appropriate practices and using these materials correctly, many of these challenges can be overcome, thus ensuring excellent clinical outcomes [54-56].

Conclusions

Ceramic-filled composite resins are a significant innovation in the field of temporary prosthetics, offering a remarkable combination of aesthetics, functionality and durability. These modern materials have managed to meet the increasingly complex requirements of patients and doctors, becoming a basic solution in temporary restorations. The integration of ceramic particles into the resin matrix ensures superior mechanical strength, allowing the use of these materials in areas subjected to intense occlusal forces.

Another major advantage of hybrid composite resins is their compatibility with modern technologies, such as CAD/CAM systems, which allow for fast and accurate performance of custom temporary jobs. This helps to reduce treatment time and increase patient satisfaction. In addition,

the materials are easy to handle, giving doctors flexibility and efficiency in the process of performing restorations. Their compatibility with modern dental adhesives ensures a stable and secure fixation, minimizing the risk of dislocation during temporary use.

However, ceramic-filled composite resins are not without limitations. Higher costs compared to traditional materials and the need for an advanced level of knowledge for optimal handling can pose challenges for some dental practices. In addition, although the materials are resistant to wear and tear, use over long periods can affect performance, especially in wet oral conditions. The repair of these materials is more complex than in the case of acrylic resins, requiring specific equipment and techniques.

The future prospects of these materials are promising. The development of resins with antimicrobial properties and deeper integration with digital technologies will bring significant improvements. Continuous research into optimising strength and aesthetics, including the use of nanoparticles, will enable the creation of even better performing materials. These advances will contribute to increasing the accessibility and efficiency of prosthetic treatments, transforming ceramic-filled composite resins into a standard of excellence in dental prosthetics.

Ceramic-filled composite resins offer significant benefits in temporary prosthetics, combining innovation with modern clinical requirements. Although there are challenges associated with their use, their aesthetic, functional benefits and adaptability to new technologies position them as an indispensable material in today's dentistry.

References

1. Liu, J.; Zhang, H.; Soare, H.; Liu, Y.; Liu, W.; Su, B.; Li, S. Dezvoltarea morfologiei de umplutură în compozitele de rășină dentară: o revizuire. *Materiale* **2021**, *14*, 5612. <https://doi.org/10.3390/ma14195612>
2. Rasines Alcaraz MG, Veitz-Keenan A, Sahrman P, Schmidlin PR, Davis D, Iheozor-Ejiofor Z. Direct composite resin fillings versus amalgam fillings for permanent or adult posterior teeth. *Cochrane Database Syst Rev.* 2014 Mar 31;(3):CD005620. doi: 10.1002/14651858.CD005620.pub2. Update in: *Cochrane Database Syst Rev.* 2021 Aug 13;8:CD005620. doi: 10.1002/14651858.CD005620.pub3.
3. Chen, H.; Wei, S.; Wang, R.; Zhu, M. Improving the Physical–Mechanical Property of Dental Composites by Grafting Methacrylate-Polyhedral Oligomeric Silsesquioxane onto a Filler Surface. *ACS Biomater. Sci. Eng.* **2021**, *7*, 1428–1437.
4. Aminoroaya A, Esmaeely Neisiany R, Nouri Khorasani S, Panahi P, Das O, Ramakrishna S. A Review of Dental Composites: Methods of Characterizations. *ACS Biomater Sci Eng.* 2020 Jul 13;6(7):3713–3744. doi: 10.1021/acsbiomaterials.0c00051.
5. Ceramic and glass-ceramic fillers in dental composites: A review *J. Met. Mater. Miner.* 30(2). 2020 29 Conservative Dentistry, vol. 19, pp. 56-62, 2016
6. Z. Tarle and M. Par, “Bioactive dental composite materials,” *Medical Sciences*, vol. 45, pp.83-100, 2018.
7. A.H. García, M.A.M. Lozano, J.C. Vila, A.B. Escribano, and P.F. Galve, “Composite resins. A review of the materials and clinical indications,” *Medicina Oral Patologia Oral y Cirugia Bucal*, vol. 11, pp. E215-220, 2006.
8. Zabrovsky A, Neeman Levy T, Bar-On H, Beyth N, Ben-Gal G. Next generation of dentists moving to amalgam-free dentistry: Survey of posterior restorations teaching in North America. *Eur J Dent Educ.* 2019 Aug;23(3):355-363. doi: 10.1111/eje.12437.
9. Verde, A.V.; Ramos, M.M.D.; Stoneham, A.M. Benefits in Cost and Reduced Discomfort of New Techniques of Minimally Invasive Cavity Treatment. *J. Dent. Res.* **2009**, *88*, 297–299.
10. He, J.; Garoushi, S.; Säilynoja, E.; Vallittu, P.K.; Lassila, L. The effect of adding a new monomer “Phene” on the polymerization shrinkage reduction of a dental resin composite. *Dent. Mater.* **2019**, *35*, 627–635
11. Herrera-González, A.M.; Pérez-Mondragón, A.A.; Cuevas-Suárez, C.E. Evaluation of bio-based monomers from isosorbide used in the formulation of dental composite resins. *J. Mech. Behav. Biomed. Mater.* **2019**, *100*, 103371.
12. Bai, X.; Lin, C.; Wang, Y.; Ma, J.; Wang, X.; Yao, X.; Tang, B. Preparation of Zn doped mesoporous silica nanoparticles (Zn-MSNs) for the improvement of mechanical and antibacterial properties of dental resin composites. *Dent. Mater.* **2020**, *36*, 794–807.
13. Yang, D.-L.; Sun, Q.; Niu, H.; Wang, R.-L.; Wang, D.; Wang, J.-X. The properties of dental resin composites reinforced with silica colloidal nanoparticle clusters: Effects of heat treatment and filler composition. *Compos. Part B Eng.* **2020**, *186*, 107791.
14. Wang, Y.; Hua, H.; Liu, H.; Zhu, M.; Zhu, X.X. Surface Modification of ZrO₂ Nanoparticles and Its Effects on the Properties of Dental Resin Composites. *ACS Appl. Bio Mater.* **2020**, *3*, 5300–5309.
15. Habib E, Wang R, Wang Y, Zhu M, Zhu XX. Inorganic Fillers for Dental Resin Composites: Present and Future. *ACS Biomater Sci Eng.* 2016 Jan 11;2(1):1-11. doi: 10.1021/acsbiomaterials.5b00401.
16. Randolph LD, Palin WM, Leloup G, Leprince JG. Filler characteristics of modern dental resin composites and their influence on physico-mechanical properties. *Dent Mater.* 2016 Dec;32(12):1586-1599. doi: 10.1016/j.dental.2016.09.034.

17. Wang, R.; Zhang, M.; Liu, F.; Bao, S.; Wu, T.; Jiang, X.; Zhang, Q.; Zhu, M. Investigation on the physical-mechanical properties of dental resin composites reinforced with novel bimodal silica nanostructures. *Mater. Sci. Eng. C* **2015**, *50*, 266–273.
18. K. H. S. Chan, Y. Mai, H. Kim, K. C. T. Tong, D. Ng, and J.C.M. Hsiao, “Review: Resin composite filling,” *Materials (Basels)*, vol. 3, pp. 1228-1243, 2010.
19. Y. Liu, Y. Tan, T. Lei, Q. Xiang, Y. Han, and B. Huang, “Effect of porous glass-ceramic fillers on mechanical properties of light-cured dental resin composites,” *Dental materials*, vol. 25, pp. 709-15, 2009.
20. P. Amdjadi, A. Ghasemi, F. Najafi, and H. Nojehdehian, “Pivotal role of filler/matrix interface in dental composites: Review,” *Biomedical Research*, vol. 28, pp. 1054-1065, 2017.
21. Alvarado, J.A.; Maldonado, A.; Juarez, H.; Pacio, M. Synthesis of Colloidal ZnO Nanoparticles and Deposit of Thin Films by Spin Coating Technique. *J. Nanomater.* **2013**, *2013*, 903191.
22. Cheng, L.; Zhou, X.; Zhong, H.; Deng, X.; Cai, Q.; Yang, X. NaF-loaded core—Shell PAN—PMMA nanofibers as reinforcements for Bis-GMA/TEGDMA restorative resins. *Mater. Sci. Eng. C* **2014**, *34*, 262–269
23. Wang X, Cai Q, Zhang X, Wei Y, Xu M, Yang X, Ma Q, Cheng Y, Deng X. Improved performance of Bis-GMA/TEGDMA dental composites by net-like structures formed from SiO₂ nanofiber fillers. *Mater Sci Eng C Mater Biol Appl.* 2016 Feb;*59*:464-470. doi: 10.1016/j.msec.2015.10.044.
24. Ilie N. Comparative Effect of Self- or Dual-Curing on Polymerization Kinetics and Mechanical Properties in a Novel, Dental-Resin-Based Composite with Alkaline Filler. Running Title: Resin-Composites with Alkaline Fillers. *Materials (Basel)*. 2018 Jan 11;*11*(1):108. doi: 10.3390/ma11010108. Erratum in: *Materials (Basel)*. 2020 Dec 07;*13*(23):E5547. doi: 10.3390/ma13235547. PMID: 29324684; PMCID: PMC5793606.
25. Cocoş DI, Dumitriu Buzia O, Tatu AL, Dinu M, Nwabudike LC, Stefan CS, Earar K, Galea C. Challenges in Optimizing Nanoplatfoms Used for Local and Systemic Delivery in the Oral Cavity. *Pharmaceutics*. 2024; *16*(5):626. <https://doi.org/10.3390/pharmaceutics16050626>
26. Dinu M, Tatu AL, Cocoş DI, Nwabudike LC, Chirilov AM, Stefan CS, Earar K, Dumitriu Buzia O. Natural Sources of Therapeutic Agents Used in Skin Conditions. *Life*. 2024; *14*(4):492. <https://doi.org/10.3390/life14040492>
27. Tüzes L, Cocoş DI, Szóts M, Bucur SM. Coronavirus prevention methods in dental practices *Romanian Journal of Oral Rehabilitation* Vol. 14, No.2 April-June 2022.
28. Bud ES , Bucur SI , Cocoş DI , Bucur SM , Bud A , Vlasa A. CHALLENGES OF USING TRANSBOND PLUS IN ORTHODONTIC TREATMENT. *Romanian Journal of Oral Rehabilitation* Vol. 13, No. 1, January – March 2021
29. Cocoş DI, Bucur SM, Coman TM, Păcurar M. Observational study on the frequency of anchorage auxiliaries in fixed orthodontics, *Romanian Journal of Oral Rehabilitation* vol. 13, nr. 3,(iulie-septembrie) anul 2021.
30. Nistor AC, Stefan CS, Topor G. POLYMERS AND HYDROGELS IN EYE SURGERY: MODERN SOLUTIONS FOR TISSUE PROTECTION AND REGENERATION. *MEDICINE AND MATERIALS* Volume 4, Issue 3, 2024: 127-134 | ISSN: 2784 – 1499 & e-ISSN: 2784 – 1537 DOI: 10.36868/MEDMATER.2024.04.03.127 |
31. Tiutiuca C, Nechita A, Bujoreanu-Bezman L, Tiutiuca DB. EVALUATION OF BIOCOMPATIBILITY OF BIOMATERIALS IN EDENTULOUS REHABILITATION. *MEDICINE AND MATERIALS* Volume 4, Issue 3, 2024: 135-140 | ISSN: 2784 – 1499 & e-ISSN: 2784 – 1537 DOI: 10.36868/MEDMATER.2024.04.03.135
32. Mocanu C, Caltabellotta C. BIOMATERIALS (METAL/CERAMIC), ADVANTAGES AND DISADVANTAGES IN MEDICAL PROSTHETICS. *MEDICINE AND MATERIALS*

Volume 4, Issue 3, 2024: 141-148 | ISSN: 2784 – 1499 & e-ISSN: 2784 – 1537 DOI: 10.36868/MEDMATER.2024.04.03.141

33. Forna DA, Mocanu C, Checherita LE. APRF+ BIOMATERIALS IN DENTISTRY: MECHANISMS, CLINICAL APPLICATIONS AND PERSPECTIVES. MEDICINE AND MATERIALS Volume 4, Issue 4, 2024: 151-156 | ISSN: 2784 – 1499 & e-ISSN: 2784 – 1537 DOI: 10.36868/MEDMATER.2024.04.04.151
34. M. Catauro and F Bollino, “Advanced glass-ceramic materials for biomedical applications,” *Journal of Bone Reports & Recommendations*, vol. 3, pp. 1-3, 2017.
35. C. Ritzberger, E. Apel, W. Höland, A. Peschke, and V. M. Rheinberger, “Properties and clinical application of three types of dental glass-ceramics and ceramics for CAD-CAM technologies,” *Materials (Basel)*, vol. 3, pp. 3700-3713, 2010.
36. Beun S, Glorieux T, Devaux J, Vreven J, Leloup G. Characterization of nanofilled compared to universal and microfilled composites. *Dent Mater.* 2007 Jan;23(1):51-9. doi: 10.1016/j.dental.2005.12.003.
37. Forna, N.C. and Sader, R., Oral rehabilitation on small substance loss cases, 2009, *Romanian journal of oral rehabilitation*, 1 (4) , pp.15-20
38. Lupescu, S ., Istrate, B ., Munteanu, C ., Minciuna, MG , Focsaneanu, S , Earar, K , Characterization of Some Master Mg-X System (Ca, Mn, Zr, Y) Alloys Used in Medical Applications *Revista De Chimie*, 2017, 68 (6) , pp.1310-1315
39. Antohe, M.E. , Stamatina, O., Pavel, D., Tibeica, A., Cretu, C ., Forna, N.C., Clinical-technological interactions of treatment in partially extended edentulousness, 2022, *Romanian journal of oral rehabilitation* 14 (1) , pp.195-204
40. Bahrin, L.G. , Lungu, N.C., Forna, N.C. , Sandu, I., Birsa, M.L. , Zwitterionic 3-(1,3-Dithiol-2-yl)phenolates, *Revista de chimie*, 2013, 64 (11) , pp.1343-1346
41. Bolat, M; Antohe, M and Forna, NC, Clinical aspects of therapeutical solutions involved in oral rehabilitation of partially edentulous patients, 2013, *Romanian journal of oral rehabilitation* 5 (4) , pp.75-81
42. Antohe, M.E. Madarati, M. Forna, N.C. , Clinical-technological interactions of treatment in partially extended edentulousness, *Romanian journal of oral rehabilitation*, 2022, 14 (1) , pp.195-204
43. Dascalu, CG , Antohe, ME , Zegan, G ., Burlea, SL , Carausu, EM , Ciubara, A , Purcarea, VL , Blended Learning - The Efficiency of Video Resources and YouTube in the Modern Dental Education, *Revista de cercetare si interventie sociala*, 2022, 72 , pp.288-310
44. Surlari, Z , Virvescu, DI , Baci, ER , Vasluianu, RI , Budala, DG ., The Link between Periodontal Disease and Oral Cancer-A Certainty or a Never-Ending Dilemma?, *APPLIED SCIENCES-BASEL*, 2021, 11 (24)
45. Iordache, C.M. , Fatu, A.M. , Văscu, M.B. , Antohe, M.E. Possibilities and limits in the rehabilitation of disturbances of the parameters of the dento-somato-facial aesthetic balance through metal-ceramic therapy, *Romanian journal of oral rehabilitation*, 2021 13 (1) , pp.311-321
46. Agop-Forna, D ., Cretu, C., Topoliceanu, C ., Salceanu, M., Vasincu, D ., Forna, N ., Clinical applications of diode lasers in oral surgery, *Romanian Journal Of Oral Rehabilitation*, 2021 13 (1) , pp.265-270
47. Scutariu, MM., Budala, DG , Davidescu, A , Romanec, C ., Ciupilan, C , Drugus, D , The performance of the romanian health system in the european context *Romanian Journal Of Oral Rehabilitation*, 2022, 14 (4) , pp.96-104
48. Belei D. , Forna N.C. , Sandu I. , Birsa M.L. , Novel Mesoionic 2-Methyl-4-(1,3-Dithiol-2-yl)phenolates, *Revista De Chimie* , 2014, 65 (1) , pp.80-83
49. Forna N.C., Dascalu C. , Forna D ., Antohe M.E. , Incidence and prevalence of dental - periodontal conditions and edentation in Moldavia, *Medical-Surgical Journal-Revista Medico-Chirurgicala* , 2013, 117 (1) , pp.205-211

50. Sarbu L.G., Lungu N.C., Forna, N.C., Birsa M.L., Synthesis of 4-(2-hydroxyphenyl)-2-dialkylamino-1,3-dithiolium Salts and Corresponding Mesoionic Derivatives, *Revista De Chimie*, 2013, 64 (12), pp.1404-1407
51. Minciuna, M.G., Vizureanu, P., Ghiban, N., Sandu, A.V., Forna, NC, Structural Characterization of Some CoCrMo Alloys with Medical Applications, *REVISTA DE CHIMIE*, 2014, 65 (3), pp.335-338
52. Lungu, N.C., Forna, N.C., Asaftei, I.V., Chirita, P., Birsa, M.L., The Influence of Bromine Substituent on Optical Properties of Some 1,3-Dithiolium Derivatives *REVISTA DE CHIMIE*, 2013, 64 (9), pp.960-964
53. Agop, M, Forna, N, Casian-Botez, I., Bejenariu, C, New theoretical approach of the physical processes in nanostructures, *Journal of computational and theoretical nanoscience*, 2008, 5 (4), pp.483-489
54. Nica, P., Vizureanu, P., Agop, M, Gurlui, S., Focsa, C., Forna, N., Ioannou, P.D., Borsos, Z.
55. Experimental and Theoretical Aspects of Aluminum Expanding Laser Plasma, *Japanese journal of applied physics*, 2009, 48 (6)
56. Buhaceanu, R., Lungu, NC, Forna, NC, Asaftei, IV, Chirita, P, Birsa, ML The Influence of Bromine Substituent on Optical Properties of Some 1,3-Dithiolium Derivatives, *Revista de chimie*, 2013, 64 (9), pp.960-964
57. Dirtu, D., Lungu, N.C., Chirita, P., et al., Synthesis of Novel 4-(3,5-Dibromo-2-hydroxyphenyl)-5-Methyl-1,3-Dithiol-2-ylidene Derivatives, *Rev.Chim.*, 67, no. 3, 2016, p.: 534-537