

Review Article

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Ceramic Block Materials Used in CAD/CAM Systems

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ABSTRACT

Today, with the increase in esthetic expectations of patients and the development of digital technologies, it has become possible to produce new generation materials that are superior to the previous ones and function better. CAD/CAM technology has advanced to a point where it provides dentist with a wide range of restorative options both chair-side and at a traditional dental laboratory. These systems which enable prosthesis making to be possible in a single chair-side time are getting increasingly common since they eliminate laboratory process and traditional impression methods, save time, diminish the risk of cross contamination to minimum and help us make more aesthetical, biocompatible restorations. With the increasing prevalence of restorations produced using CAD/CAM systems, new materials have started to be introduced rapidly. Ceramics are the most commonly used materials in CAD/CAM systems because of the fact that they are the best materials that can imitate the natural tooth. The purpose of this article is to introduce the current ceramic materials used in CAD-CAM systems.

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Introduction

The most important aim of prosthetic dental treatment is to replace lost teeth and tissues and to restore esthetics, function and phonation. For this purpose, precious and non-precious metal alloys, acrylic and composite based resins and ceramics with different physical and structural properties were used. Ceramics, which have many advantages such as color, optical properties, light transmittance (translucency) and tissue compatibility compared to other materials, are still the most preferred materials [1-3]. In recent years, the use of CAD-CAM systems in dentistry, especially in prosthetic dental treatment, has become quite widespread [4]. The evolution of computerized systems for the production of dental restorations associated to the development of novel microstructures for ceramic materials has caused an important change in the clinical workflow for dentists and technicians, as well as in the treatment options offered to patients [5].

CAD/CAM in Dentistry

CAD-CAM refers to a computer system that is used to both design and manufacture a dental restoration. CAD technology uses a software to define the shape and dimensions of the restoration, while CAM technology takes the designed model to a computer numeric control (CNC) machine to manufacture the restoration, usually from a block made of a dental material [5]. This technology, which has been used in the industry for many years, started with the first applications of CAD / CAM technology in dentistry in the 1970s with Bruce Altschuler in the USA, Francois Duret in France, Werner Mormann and Marco Brandestini in Switzerland [6, 7]. In 1984, Duret introduced the "Duret system" [8]. The first

commercially produced CAD/CAM system was CEREC (Sirona, Bensheim, Germany) developed by Mormann and Brandestini in 1980 [9, 10].

Today, CAD/CAM systems have a wide range of indications such as inlays, onlays, laminate veneers, partial crowns, all-ceramic crown and bridge systems, skeletal structures of removable partial dentures, and production of stents used in implant surgery [11].

Dental CAD/CAM systems consist of three functional elements [12, 13].

1. Optical or mechanical scanner that digitizes the three-dimensional geometry of the preparation
2. The software program in which the data of the product to be obtained is created and the design of the dental restoration is made.
3. Milling unit that transforms the designed data into the desired restoration [2].

Ceramic Block Materials used in CAD/CAM Systems

In the traditional method, fragile dental ceramics were used by being supported by a strong metal infrastructure. However, today, with the developments in CAD/CAM technology, the production of monolithic restorations has become possible in dentistry [14, 15].

Monolithic CAD/CAM materials used for this purpose can be listed as follows: [2].

- 1-Feldspathic ceramics
- 2-Leucite reinforced ceramics
- 3-Glass ceramics reinforced with lithium disilicate

4-Ceramics reinforced with zirconia
5-Yttrium-tetragonal zirconia polycrystalline ceramics
6-Oxide ceramics
7-Nanoceramics
8-Hybrid ceramics

Feldspathic Ceramics

Feldspar-based glasses are highly biocompatible. Feldspathic ceramic blocks can be used in inlay, onlay, laminate veneer, anterior partial or full crown construction [16, 17].

Blocks used

VITABLOCKS Mark II (*VITA, BadSäckingen, Germany*) blocks can be used both in the clinic and in the laboratory [18].

VITABLOCS RealLife (*VITA, BadSäckingen, Germany*) blocks are produced especially for anterior restorations where aesthetic expectations increase [18].

CerecBlocs C In (*Sirona, NY, USA*) blocks are silicate ceramic blocks that can be processed in the CEREC unit [19].

Leucite Reinforced Ceramics

The properties of these materials such as color, translucency, fluorescence, opalescence, abrasion and abrasion resistance are similar to natural teeth. It can be used in anterior crown prostheses, inlays, onlays and laminate veneers [20].

Blocks used

IPS Empress CAD (*Ivoclar Vivadent, Schaan, Lihtensteyn*) and Paradigm™ C (*3M/ESPE, Saint Paul, MN, USA*) blocks from 3M ESPE are examples of leucite-reinforced glass ceramic blocks [21].

Glass Ceramics Reinforced with Lithium Disilicate

These ceramics have improved resilience, good optical properties, and many levels of translucency and tints. These ceramic blocks can be used in restorations such as veneers, inlays, onlays, endocurons, anterior and posterior crowns [22].

Blocks used

IPS e.max CAD block. These blocks with high translucency can be used in the construction of inlays, onlays and full crown restorations due to their chameleon effect and aesthetic properties [23, 24].

Zirconia Reinforced Lithium Disilicate Ceramics

Lithium disilicate reinforced glass ceramics was one of the first blocks used in CAD/CAM systems. These blocks are now mechanically developed to produce zirconia reinforced lithium disilicate ceramic blocks. These monolithic CAD/CAM materials are indicated for the manufacture of inlays, onlays, laminate veneers, anteroposterior and implant supported crown prostheses [25, 26].

Blocks used

Vita Suprinity (*VITA Zahnfabrik, Bad Säckingen, Germany*) and Celtra DeguDent (*DeguDent, Hanau, Germany*) are examples of zirconia reinforced ceramic blocks.

Yttrium-Tetragonal Zirconia Polycrystalline Ceramics (Y-TZP)
It is zirconium stabilized with 3 mol% yttrium oxide and alumina crystal. Its partially stabilized structure facilitates its processing. Monolithic zirconia restorations can also be used in the manufacture of posterior crown prostheses in individuals with parafunctional habits such as insufficient occlusal distance and

bruxism. However, due to the fact that zirconia is a white opaque material and insufficient aesthetic properties, its use is limited to posterior region crown prostheses [26].

Blocks used

Lava all-Zirconia (*3M ESPE, Seefeld, Germany*), Zircon Zahn (*Zirconzahn GMBH, Bruneck, Italy*) and BruxZir Solid Zirconia (*Gildewell laboratories, California, USA*) are blocks introduced for use in the manufacture of monolithic zirconia restorations [27].

Oxide Ceramics

This ceramic system is called the In-Ceram ceramic system. It is called InCeram because molten glass particles are infiltrated into the sintered oxide substrate.

Blocks used

Representatives of the In-Ceram system are In-Ceram Alumina, In-Ceram Spinell and In-Ceram Zirconia (*Vita, D-Bad Säckingen*).

Nanoceramics

Nanoceramics and resin composites have the same microstructure but different proportions. Nanoceramic blocks are blocks with high durability. These blocks are indicated for veneers, inlay/onlay, anterior and posterior single crowns, anterior and posterior bridges [28].

Blocks used

LAVA Ultimate (*3M ESPE, Neuss, Minn, USA*); It is a new material produced with nanoceramic technology and is called resin nanoceramic (RNC).

Cerasmart (*GC Dental Products, USA*); flexible nanoceramic is available in the literature [29].

Hybrid Ceramics

Hybrid blocks have lower durability than glass ceramic and nanoceramic blocks [30].

Blocks used

Vita Enamic (*Vita Zahnfabrik, Bad Säckingen, Germany*). Fracture strength is higher than full ceramics and the preparation procedure is easier with CAD/CAM systems [31].

Vita enamic is indicated in implant prostheses as well as veneers, inlay/onlay, anterior/posterior single crowns.

Summary

New technological products and materials are entering dentistry clinics every day. The popularity of CAD/CAM technology in dentistry is increasing day by day. Today, dental materials used for CAD/CAM systems are rapidly increasing and developing. For this reason, it is an issue that should be constantly followed by dentists.

References

1. Karataşlı B, Bultan B, Özer Y (2015) Dental CAD-CAM Materials. Turkey Clinics J. of Prosthodontics-Special Topics 1: 1-7.
2. Turan C (2020) Ceramic Blocks Used in CAD-CAM Systems. Thesis. Istanbul University Faculty of Dentistry, Crown Bridge Prosthesis Department 1-31.
3. Bornfather KDP, Brunton PA (2007) Restoration of the upper dental arch using Lava allceramic crown and bridgework. British Dental Journal 202: 731-735.
4. Tinschert J, Natt G, Hassenpflug S, Spiekermann H (2004)

- Status of current CAD/CAM technology in dental medicine. *Int J Comput Dent* 7: 25-45.
5. Silva LH, Lima de E, Miranda PBR, Favero SS, Lohbauer U, et al. (2017) Dental ceramics: a review of new materials and processing methods. *Braz. Oral Res* 31: e58.
6. Young JM, Altschuler BR (1977) Laser holography in dentistry. *J Prosthet Dent* 38: 216-225.
7. Şen, N, Tuncelli B (2017) Materials Used for the Production of CAD/CAM Restorations. *Turkey Clinics J Dental Sci* 23: 109-115.
8. Duret F, Blouin JL, Duret B (1988) CAD-CAM in dentistry. *J Am Dent Assoc* 117: 715-720.
9. Mörmann WH, Bindl A (2002) All-ceramic, chair-side computer-aided design/computer-aided machining restorations. *Dent Clin North Am* 46: 405-426.
10. Liu PR (2005) A panorama of dental CAD/CAM restorative systems. *Compend Contin Educ Dent* 26: 507-512.
11. Leinfelder KF, Isenberg BP, Essig ME (1989) A new method for generating ceramic restorations: A CAD/CAM system. *J Am Dent Assoc* 118: 703-707.
12. Gerber A (1970) Registration technique for prosthetics occlusion diagnostics occlusion therapy. *Condylator Service Zurich*.
13. Hickel R, Dasch W, Mehl A, Kremers L (1997) CAD/CAM-fillings of the future?. *Int Dent J* 47: 247-258.
14. Mehl A, Hickel R (1999) A new optical 3D-scanning system for CAD/CAM technology. *Int J Comput Dent* 2: 129-136.
15. Fischer H, Marx R (2002) Fracture toughness of dental ceramics: comparison of bending and indentation method. *Dent Mater* 18: 12-19.
16. Otto T, De Nisco S (2002) Computer-aided direct ceramic restorations: a 10-year prospective clinical study of Cerec CAD/CAM inlays and onlays. *Int J Prosthodont* 15: 122-128.
17. Kelly JR, Benetti P (2011) Ceramic materials in dentistry: historical evolution and current practice. *Aust Dent J* 56: 84-96.
18. Denry I, Kelly JR (2008) State of the art of zirconia for dental applications. *Dent Mater* 24: 299-307.
19. VITA (2015) VitaBlocs. Product Information., BadSäckingen, Germany. www.vita-zahnfabrik.com/en/VITABLOCS-Mark-II-25030,27568,85234.html <http://www.sirona.com/en/products/digital-dentistry/cadcam-materials/?tab=254>.
20. Fasbinder DJ, Dennison JB, Heys D, Neiva GA (2010) clinical evaluation of chairside lithium disilicate CAD/CAM crowns: a two-year report. *J Am Dent Assoc* 141: 10S-14S.
21. Fasbinder DJ (2012) Chairside CAD/CAM: an overview of restorative material options. *Compend Contin Educ Dent* 33: 50-58.
22. Bindl A, Lüthy H, Mörmann WH (2006) Strength and fracture pattern of monolithic CAD/CAM-generated posterior crowns. *Dent Mater* 22: 29-36.
23. Fasbinder DJ, Dennison JB, Heys D, Neiva GA (2010) clinical evaluation of chairside lithium disilicate CAD/CAM crowns: a two-year report. *J Am Dent Assoc* 141: 10S-14S.
24. The Reich S, Fischer S, Sobotta B, Klapper HU, Gozdowski S (2010) A preliminary study on the short-term efficacy of chairside computer aided design/computer-assisted manufacturing- generated posterior lithium disilicate crowns. *Int J Prosthodont* 23: 214-216.
25. Güth JF, Zuch T, Zwinge S, Engels J, Stimmelmayer M, et al. (2013) Optical properties of manually and CAD/CAM-fabricated polymers. *Dent Mater J* 32: 865-871.
26. Griffin JD Jr (2013) Tooth in a bag: same-day monolithic zirconia crown. *Dent Today* 32: 126-131.
27. Koutayas SO, Kern M (1999) All-Ceramic Posts And Cores: The State Of The Art. *Quintessence Int* 30: 383-392.
28. Wiegand A, Stucki L, Hoffmann R, Attin T, Stawarczyk B (2015) Repairability of CAD/CAM high-density PMMA- and composite-based polymers. *Clin Oral Investig* 19: 2007-2013.
29. GC Cerasmart Product Description (2014) 800.323.7063 www.gcamerica.com.
30. Rosenblum M.A., Schulman A (1997) A review of all-ceramic restoration. *J Am Dent Assoc* 128: 297-307.
31. Johnson AC, Versluis A, Tantbirojn D, Ahuja S (2014) Fracture strength of CAD/ CAM composite and composite-ceramic occlusal veneers. *J Prosthodont Res* 58: 107-114.

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