RECENT ADVANCES IN ESTHETIC RESTORATIVE MATERIALS : DENTAL CERAMICS


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INTRODUCTION:

In today's world looking good is a prime concern. Dentistry has now evolved from a curative to creative science. Aesthetic dentistry is harmonious integration of oral physiologic function with equal emphasis on promoting pristine ideal dentition through the restoration of colour, shape, form and function to ensure optimal health and durability, attention to long term well-being, reactions and functions in primary. The most commonly used esthetic materials are ceramics and composites.

Dental ceramics are materials that are part of systems designed with the purpose of producing dental prosthesis that in turn are being used to replace missing or damaged dental structures.[1]

The success of all-ceramic crowns and patient demand for metal-free, tooth-colored restorations has led to the development and introduction of restorative systems for all-ceramic fixed partial dentures (FPDs).[2]

Ceramic materials are best able to mimic the appearance of natural teeth however two obstacles have limited the use of ceramics in the fabrication of dental prostheses:

(1) Brittleness leading to a lack of mechanical reliability

(2) Greater effort and time required for processing in comparison with metal alloys and dental composites.

Recent advances in ceramic processing methods have simplified the work of the dental technician and have allowed greater quality control for ceramic materials, which has increased their mechanical reliability. This review article is about the recent advances in Ceramics.[3]

CLASSIFICATION:

1. Ceramics can be classified by the processing techniques :

a. Conventional (Powder-liquid) System
b. Infiltrated Ceramics
c. Pressable Ceramics
d. Castable Ceramics
e. Machinable Ceramics

2. Ceramics can also be classified by their microstructure (amount and type of crystalline phase and glass structure) as (Figure 1)[1,4,7,8]

(1) Predominantly glassy materials,
(2) Particle-filled glasses,
(3) Polycrystalline ceramics.

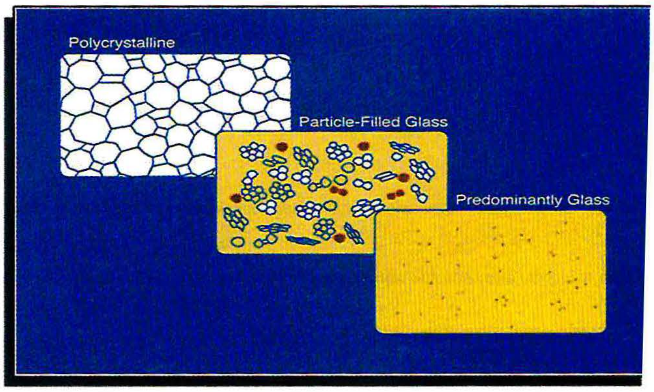

Figure 1.Schematic representation of three basi classes of dental ceramics. Predominantly glass-based ceramics are lightly filled with colorants an opacifiers to mimic natural esthetics and are th weakest ceramics. Glasses containing 35 to 70 pe cent filler particles for strength can be moderately e thetic as full-thickness restorations, but general they are veneered. Completely polycrystalline ceran ics (no glass), which are used to create strong sul structures and frameworks via computer-aide design/ computer-aided manufacturing processe always are veneered.

I} PREDOMINANTLY GLASS CERAMICS:[1,4,5,6, 9,10,11,12]

Dental ceramics that best mimic the optical properties of enamel and dentin have a high glass content.Mainly contain silicon-dioxide and alumina. Feldspathic porcelains belong to a family called aluminosilicate glasses.

SYSTEMS:	MANUFCTURING TECHNIQUES	USES
VITABLOCS Mark II (VITA)	Milled	Veneer for ceramic substructures, inlays, onlays, veneers, ¾ crowns.
VITA TriLuxe Bloc (VITA)	Milled	Veneer for ceramic substructures, inlays, onlays, veneers, ¾ crowns.
VITABLOCS Esthetic Line (VITA)	Milled	Veneer for ceramic substructures, inlays, onlays, veneers, ¾ crowns.

II} PARTICLE FILLED GLASS: [1,4,5, 9,10,11,12]

Filler particles are added to the base glass composition to improve mechanical properties and to control optical effects such as opalescence, color, and opacity. It can be glass based systems with crystalline fillers (leucite, lithium disilicate) or crystalline based systems with glass fillers (alumina).

LEUCITE REINFORCED FELDSPAR GLASS CERAMICS:

SYSTEMS	MANUFACTURING TECHNIQUE :	USES
IPS Empress (Ivoclar)	Heat pressed	Onlays, 3/4 crowns, crowns
OptimalPressable Ceramic (Pentron)	Heat pressed	Onlays, 3/4 crowns, crowns
IPSProCAD (Ivoclar)	Milled	Onlays, 3/4 crowns, crow

LITHIUM DISILICATE REINFORCED FELDSPAR GLASS CERAMICS:

SYSTEMS	MANUFACTURING TECHNIQUE :	USES
IPS Empress 2(Ivoclar)	Heat pressed	Crowns, anterior FPD.
IPSe.max (Ivoclar)	Heat pressed	Onlays, ¾ crowns, crowns, FPD

CRYSTALLINE BASED SYSTEMS WITH GLASS FILLERS: [1,4,5,9,10,11,12]

SYSTEMS	MANUFACTURING TECHNIQUE	USES
In-Ceram Alumina (VITA)	Slip cast, Milled	Crowns, FPD.
In-Ceram Spinell (VITA)	Milled	Crowns
Synthoceram (CICERO Dental Systems)	Milled	Onlays, ¾ crowns, crowns
In-Ceram Zirconia (VITA)	Slip cast, Milled	Crowns, posterior FPD
Procera (Nobel Biocare)	Densely sintered	Veneers, crowns, anterior FPD

III} POLYCRYSTALLINE CERAMICS :

Yttrium tetragonalzirconia olycrystals[1,4,5,9,10,11,12]

SYSTEMS	MANUFACTURING TECHNIQUE	USES
Lava (3M ESPE)	Green milled, sintered	Crowns, FPD
Cercon (Dentsply)	Green milled, sintered	Crowns, FPD
C-Zirkon (DCS Dental AG)	Milled	Crowns, FPD
Denzir (Decim AB)	Milled	Onlays, ¾ crowns, crowns
Procera (Nobel Biocare)	Densely sintered, milled	Crowns , FPD, implant abutments

Glass ceramics:[1,2,3,4,5]

IPS Empress:

It is a leucite-reinforced glass ceramic (SiO_2-Al_2O_3-K_2O).

Flexural strength of IPS Empress is 121 MPa.

So used for single tooth in anterior region.

IPS Empress 2:

It is a lithium-disilicate glass ceramic (SiO_2-Li_2O) that is fabricated through a combination of the lost-wax and heat-pressed techniques. Flexural strength is 300-400 MPa. The framework is veneered with fluoroapatite-based veneering porcelain (IPS Eris), resulting in a semi-translucent restoration with enhanced light transmission.

It can be used for 3-unit FPDs in the anterior area and can extend to the second premolar.

IPS e.max Press:

It was introduced in 2005 as an improved press-ceramic material compared to IPS Empress 2. It also consists of a lithium-disilicate pressed glass ceramic, but its physical properties and translucency are improved through a different firing process.

IPS ProCAD:
It is a leucite-reinforced ceramic similar to IPS Empress, although it has a finer particle size. It was introduced in 1998 and was designed to be used with the CEREC in Lab system (Sirona Dental Systems, Bensheim, Germany) . It is available in numerous shades, includinga bleached shade and an esthetic block line.

Vita Mark II:
It is a machinable feldspathic porcelain introduced in 1991 for the CEREC 1 system (Siemens AG, Bensheim, Germany).It has improved strength and finer grain size (4 µm) as compared to the Vita MarkI. It is primarily composed of SiO_2 (60-64%) and Al_2O_3 (20-23%) and can be etched with hydrofluoric acid to create micromechanical retention for adhesive cementation with composite resin cements.
Although thisproduct is monochromatic, it is available in multiple shades, including the Classic Line Vita shades, Vitapan 3DMaster Shades, VITABLOCS Esthetic Line, and a bleached shade, and canbe additionally characterized.
To overcome esthetic disadvantages of amonochromatic restoration and to imitate optical effects of natural teeth, a multicolored ceramic block (Vita TriLuxe Bloc; VITA Zahnfabrik) was designed to create a 3-dimensional layered structure. The inner third has a dark opaque base layer, while the middle third has a neutral zone comparable to the standard block, and the outer third is more translucent. CEREC software allows the operator to have some visual control over the alignment of the restoration within the multilayered block.

Alumina-based ceramics [1,2,3,4,5,9,10,11,12]

In-Ceram Alumina (glass infiltrated Alumina):
It was introduced in 1989 and was thefirst all-ceramic system available for single-unit restorations and 3-unit anterior FPDs. It has a high strength (236-600MPa) ceramic core fabricated through theslip-casting technique. The coping is veneered with feldspathic porcelain. Alumina blanks (VITABLOCS In-Ceram Alumina; VITA Zahnfabrik) are also available for milling in combination with CEREC (Sirona Dental Systems). Because of large difference in the refraction index intense refraction of light occurs at the aluminium oxide crystals in the feldspar, which result in the opaque effect. Therefore they are only suitable for fabrication of crown frames with subsequent veneering.

In-Ceram Spinell
(Glass infiltrated magnesium alumina): It was introduced in 1994 as an alternativeto the opaque core of In-Ceram Alumina. It contains a mixture ofmagnesia and alumina ($MgAl_2O_4$) in the framework to increase translucency. Its flexural-strength is lower than that of In-Ceram Alumina (350MPa) thus, the cores are only recommended for anterior crowns. This material can also be machined with the CEREC in Lab system (Sirona Dental Systems), followed by veneering with feldspathic porcelain.
Synthoceram: It is a high-strength glass-impregnated aluminum oxide ceramic core fabricated through CICERO technology (Computer Integrated Ceramic Reconstruction). Laser scanning, ceramic sintering and computer-integrated milling techniques are used to fabricatethe cores, which are veneered with a leucite-free glass ceramic.

In-Ceram Zirconia (Glass infiltrated alumina with partially stabilized Zirconia):
It is also a modification of the original In-Ceram Alumina system, with an addition of 35% partially stabilized zirconia oxide to the slip composition to strengthen the ceramic.
Its flexural strength is 421-800 MPa. Traditional slip-casting techniques can be used or the material can be copy-milled from prefabricated, partially sintered blanks and then veneered with feldspathic porcelain. Since the core is opaque and lacks translucency, the material is recommended for posterior crown copings and FPD frameworks.

Procera (Densely sintered high purity aluminium oxide):
Copings that contain 99.9% high purity aluminum oxide.Procera have the highest strength (487-699 MPa) of the alumina-based materials and its strength is lower only than zirconia. A sapphire contact probe is used to scan the working die and to define the 3-dimensional shape of the preparation. The data is sent electronically to a manufacturing facility where a 20% enlarged model is copy-milled and used for the dry pressing technique. High purity aluminum-oxide powder is mechanically compacted on the enlarged die and sintered at 1550°C, eliminating porosity and returning the core to the dimensions of the working die. The crown form is completed by veneering it with low-fusing feldspathic porcelain matching the coefficient of thermal expansion of aluminum oxide. It is relatively more opaque & indicated for veneers crowns & anterior FPDs.

Zirconia based ceramics:[1,2,3,4,5, 9, 10,11,12,13t]

Yttrium-oxide partially stabilized zirconia polycrystals (Y-TZP) are the basis for the high strength (900-1200 Mpa), glass-free polycrystalline ceramic material used for the fabrication of anterior & posterior crown copings & fixed partial denture frameworks.

The strength of the material is due to a process known as transformation toughening.

Yttrium-oxide (Y2O3 3% mol) is added to pure zirconia to control the volume expansion and to stabilize it in the tetragonal phase at room temperature. This partially stabilized zirconia has high initial flexural strength and fracture toughness. Tensile stresses at a crack tip will cause the tetragonal phase totransform into the monoclinic phase with an associated 3-5% localized expansion. The volume increase creates compressive stresses at the crack tip that counteract the external tensile stresses. The cores have a radiopacity comparable to metal which enhances radiographic evaluation of marginal integrity, excess cement removal and recurrent decay.

CONCLUSION: All-ceramic restorations differs from metal-ceramic restorations in having a core made up of glass ceramics, aluminum oxide, or zirconium oxide,and are manufactured by heat pressing,slip-casting, sintering, or milling. Intraoral conditions and esthetic requirements of the patient should be kept in mind before selecting the appropriate material, manufacturing technique and bonding procedure [5].

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