Review Article

Dental Ceramics: Material Options and Clinical Recommendations

Sohil Rajkumar Daswani, Meena A. Aras, Vidya Chitre, Praveen Rajagopal

Department of Prosthodontics, Goa Dental College and Hospital.

Corresponding Author

Dr. SohilDaswani

Room number F-115, Goa Dental

College Men's hostel.

Bambolim Goa 403202

Email: sohildaswani@gmail.com

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Abstract

The new generation of dental ceramic materials present interesting options, both in terms of material selection and in terms of fabrication techniques. Advances in bonding techniques have increased the range and scope for use of ceramics in dentistry. This brief review shall discuss the important properties of some currently available ceramic materials and provide guidelines to help select an appropriate ceramic material for a particular clinical situation. Failure of a ceramic prosthesis due to selection of an incorrect ceramic material can almost completely be avoided with sound knowledge of the various properties of ceramic materials and their specific indications and limitations.

Keywords: Ceramics, options, applications, recommendations

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Introduction

With the increase in technological advancements, dental materials are constantly undergoing changes. Dental ceramics today form an important section of esthetic and restorative dentistry and for this reason there has been a continuous effort to manufacture materials that meet both ideal esthetic as well as functional requirements.

Newer ceramic materials are constantly being evolved and marketed under various brand names, thus it has become imperative for the dentist to have sound knowledge of the various materials available today. This will enable one to make an informed decision while selecting a ceramic material for a particular situation rather than depending upon laboratory recommendations. This article presents a practical approach for selecting the right ceramic material based on its composition, properties, applications and manufacturing process.

Classification of Dental Ceramics:

A) Based on Microstructure:

Ceramic materials are micro structurally composed of two or more entities (i.e. a glass phase and a crystalline phase) based on their glass to crystalline ratio they can be broadly divided into[1]:

Category 1: glass based systems (mainly silica).

Category 2: glass based systems (mainly silica) with fillers, usually crystalline (typically leucite or more recently lithium disilicate)

Category 3: crystalline based systems with glass fillers.

Category 4: polycrystalline solids (alumina and zirconia.)
In general ceramic materials with a larger glassy phase are more esthetic but have poor mechanical properties, whereas polycrystalline ceramics have excellent mechanical properties with relatively inferior esthetic properties[2].

B) Based on Applications:
From the view point of applications in dentistry, ceramics can broadly be classified as[3]:
Esthetic Ceramics: Usually are predominantly glassy in structure and are used for layering over metal or ceramic substructures. (Table 1a)
Structural Ceramics: Usually contain a higher polycrystalline component and form the core or substructure over which esthetic ceramics are layered. (Table 1b)
Table 1a and 1b represents a chart of some commercially available dental ceramic systems based on the matrix material, filler concentration, applications, fabrication process and trade name.

Clinical Recommendations Based on:

I) Indications for the Restorative Material:[4]

Metal Ceramic Systems: 17-25 % leucite and feldspathic glass ceramics layered onto an underlying metal substructure are indicated primarily for full-coverage esthetic posterior applications, especially in high stress areas or for fixed partial denture applications.

All Ceramic Systems: 40-50 % Leucite and feldspathic glass ceramics: Indicated for onlays, three quarter crowns, and veneers, but their strength limits their use to complete coverage crowns in the anterior segment, only.

Lithium-disilicate glass ceramics: Indicated for use in the posterior segment for single crowns usually premolars and for single crowns and 3-unit Fixed Partial Denture Prosthesis (FPDPs) in the anterior regions only.

Glass-infiltrated alumina cores: Indicated for single-unit anterior and posterior restorations and anterior 3 unit FPD applications, with the exception of In-Ceram Spinell, which is only recommended for anterior crowns.

Zirconia-modified alumina restorations: Indicated for posterior crowns and FPDs.

Densely sintered aluminium oxide ceramic restorations: Indicated for veneers,crowns, and 3 unit anterior FPDPs, implant abutments.

Densely sintered zirconium oxide ceramic restorations: Indicated as a core material for posterior crowns and FPDs, implant abutments, and implant-supported restorations, restorations for patients with bruxism. The stronger ceramic core materials can be rather opaque and this may limit their application when a high degree of translucency is required.

II) Cementation and bonding of the prosthesis:

Metal Ceramic Systems: Glass Ionomer cement is used primarily in the cementation of metal ceramic restorations. In clinical situations where moisture control is difficult Resin Modified Glass Ionomer cement is preferred. In clinical situations with excessively tapered preparations composite resin cements can be used for cementation of the restoration after treating the metal surface with a suitable metal primer that allows the acrylate components of the cement to chemically bond to the metal surface.[5]

All Ceramic Systems:
a) Conventional glass-ceramic restorations: Considering the brittleness and limited flexural strength of glass ceramics, definitive adhesive cementation with composite resin should be used to increase the fracture resistance of the restoration.[6,7] Surface treatment of the porcelain by etching with 5% to 9.5% hydrofluoric acid[8] and etching of the tooth

Table 1 (A): Esthetic Ceramics

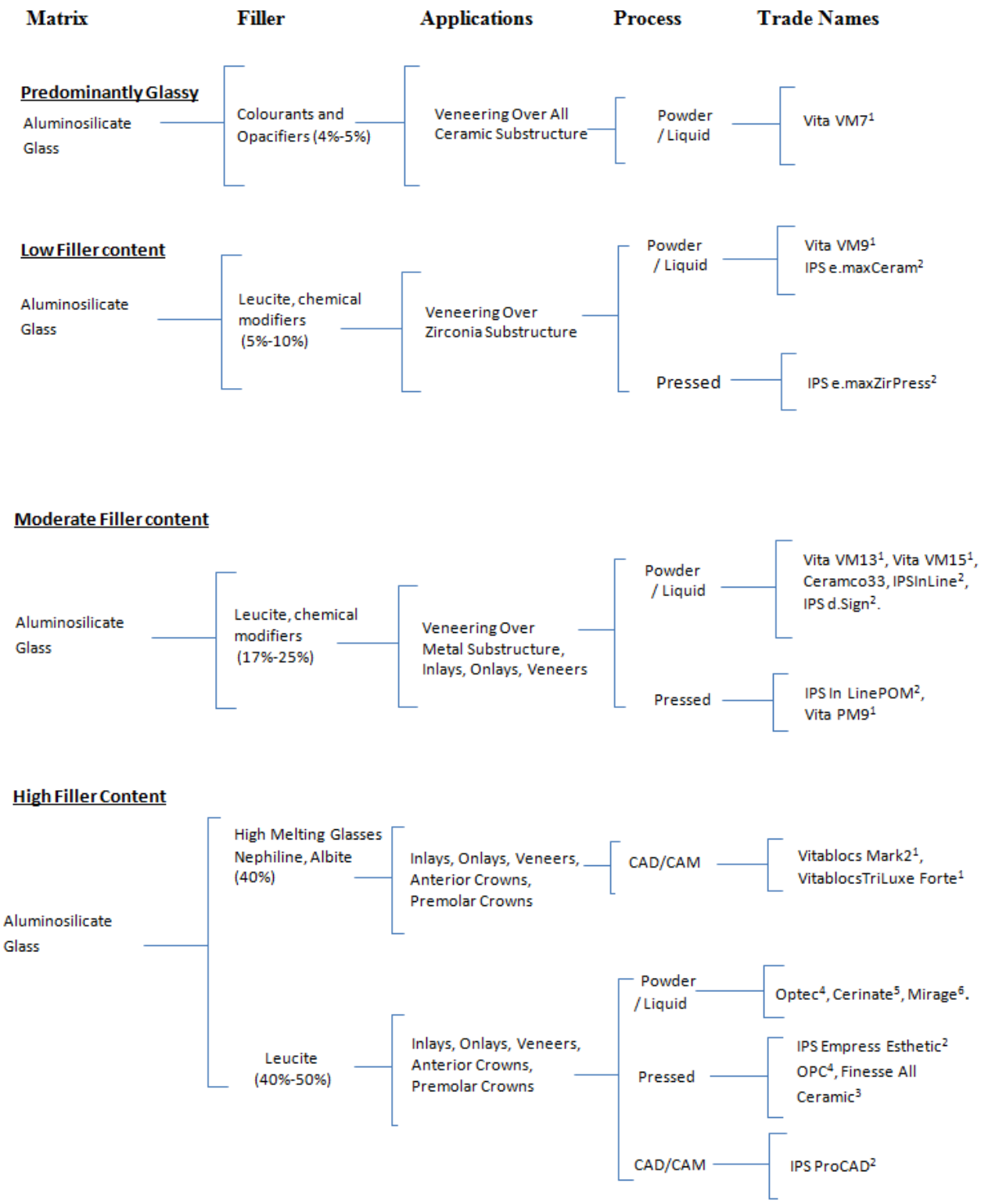
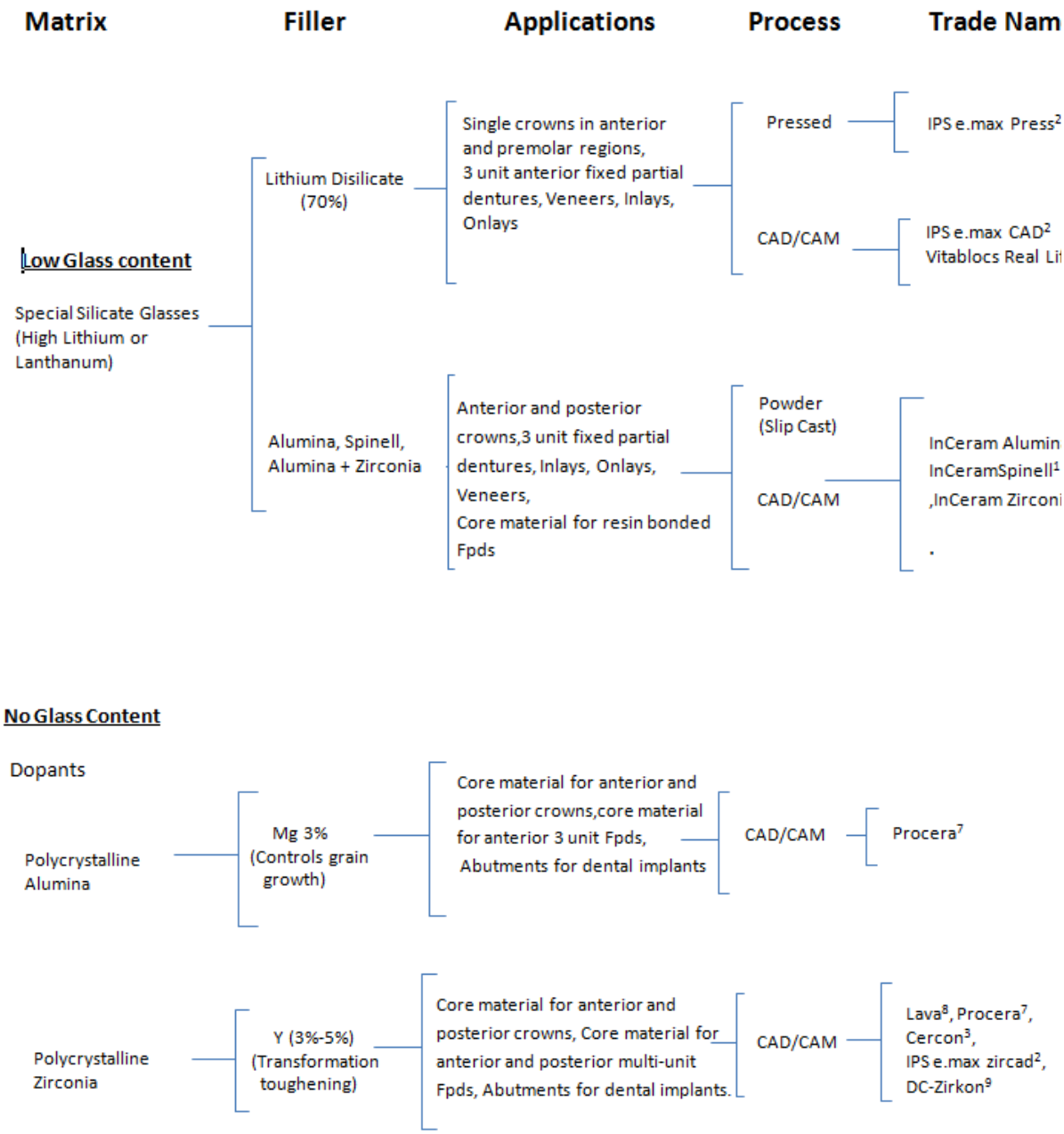


Table 2: Structural Ceramics



Polycrystalline ceramics do not contain fillers but have dopants which are modifying atoms.

Key: The superscripted numbers correspond to manufacturers : 1-Vita Zahanfabrik; 2-Ivoclar Vivadent; 3-Dentsply Prosthetics; 4-Pentron; 5-Den Mat; 6-Chameleon Dental Products; 7-Nobel Biocare; 8-3M ESPE; 9-DCS Popp Dental Laboratory.

structure with 37% phosphoric acid[9] and application of a silane coupling agent provided the highest bond strength of an adhesive-resin cement to feldspathic material.

b) Glass-infiltrated alumina-based ceramic restorations (In-Ceram, Vita Zahnfabrik): Acid etchants used with glass ceramics do not adequately roughen the surface of glass-infiltrated and densely sintered alumina- based ceramics. An effective method to roughen glass-infiltrated alumina-based ceramic restorations is through a tribochemical silica coating process (Rocatec; 3M ESPE). This method involves cleaning the surface to be coated with 110 µm of high-purity aluminium oxide (Rocatec Pre; 3M ESPE) at 250 KPa for 14 seconds, creating a uniform pattern of roughness. This is followed by a tribochemical coating with 110 µm (Rocatec Plus; 3M ESPE) or a less abrasive 30 µm (Rocatec Soft; 3M ESPE) of silica modified high purity aluminium oxide. The aluminium oxide leaves the surface partially coated with SiO2, which is then conditioned with silane (3M ESPE Sil; 3M ESPE) to create a bond with the composite resin.[10]

c) Densely sintered aluminium oxide ceramic restorations (Procera; Nobel Biocare AB): Surface treatment of the porcelain by airborne-particle abrasion with 50µm aluminium oxide for 15 seconds was found to be the most effective for producing higher bond strengths for a densely-sintered aluminium-oxide coping.[4]

d) Densely sintered zirconium oxide ceramic restorations: While mechanical properties of cements are critical to support glass-ceramic restorations, zirconia-based crowns can be cemented conventionally due to their high fracture resistance.[11] A variety of luting agents have been shown to be capable of retaining zirconium-oxide crowns including composite resin (Panavia F 2.0; Kuraray, Tokyo, Japan), compomer (Dyract Cem Plus; Dentsply Intl), resin-modified glass ionomer (RelyX Luting; 3M ESPE),and self-adhesive composite resin (RelyX Unicem; 3M ESPE),(Multilink Automix; Ivoclar Vivadent)[11,12]

III) Space requirements and colour change:[13]

Metal ceramics require a thickness of at least 1.5mm to 1.7 mm to create life like esthetics.

In general a porcelain thickness of 0.2mm to 0.3mm is required for each shade change.For example a veneer of 0.6mm to 0.9mm thick would be required to change the shade from A3 to A0.

Glass ceramics require 0.8mm of minimum working thickness and 0.2 to 0.3mm for each shade change.

High strength all ceramic crowns require 1.2mm of minimum working thickness and 1.5mm if masking is required.

IV) Clinical scenarios in anterior esthetic zone:[14]

Four commonly occurring scenarios in the anterior esthetic zone have been described below:

a) Partial Enamel Replacement: Porcelain laminate veneers are the preferred restorations when the underlying tooth colour is pleasing and only restoration of the external surface is needed without changing the tooth colour significantly. These ceramic restorations are usually 0.3 to 0.5mm thick and thus only translucent un-layered materials are preferred. Eg. Leucite and feldspathic glass ceramics.

b) Dentin and enamel replacement: Partial-coverage restorations that replace enamel and dentin are indicated in situations involving large interproximal restorations, tooth malposition, tooth discoloration, wear or fractures that may require a restoration that involves the removal of more tooth structure but does not necessitate a conventional complete-coverage crown. When the clinician must

replace both dentin and enamel but will not alter the occlusion or colour, translucent ceramics still are the materials of choice, because of their excellent enamel like appearance and ability to be bonded to natural tooth structure. Eg. Leucite and feldspathic glass ceramics.

c) Complete crown and acceptably coloured dentin: Complete-coverage crowns for an anterior tooth are usually indicated for replacement of an existing crown, to significantly change the occlusion or the presence of large interproximal areas of decay. In such situations it may be difficult to decide whether to use translucent materials or opaque layered materials because both may work equally well. In general, the decision will be based on the need for high strength owing to the lack of anterior guidance or the presence of para-functional habits, the amount of tooth reduction required, and whether the clinician wishes to cement or adhesively bond the restoration.

d) Complete crown and discoloured dentin or metallic post: A predictable approach is the use of an opaque core that is less affected by the preparation colour which is then layered with a more translucent material to achieve an esthetic final appearance. Eg. Layered lithium disilicate glass ceramics, Glass infiltrated high strength ceramic core systems and polycrystalline ceramics.

Conclusion

Dental ceramic materials today are available in a wide variety of options; the task of selecting an appropriate ceramic material in a particular situation can often present as a challenge to the dentist. A closer understanding of the dynamics of these materials with respect to design of the restoration and the intended use is required to enable these restorations to perform productively. Failure of a ceramic prosthesis due to material failure can be avoided with sound knowledge of the various properties of ceramic materials their specific indications and limitations.

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