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Ceramics-The Phase value in Dental Practice

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ABSTRACT: Ceramics have become a part of use in almost every field ,Dentistry being an important entity,This article would mention the uses ,types and application with the future of ceramics use in dentistry

I. INTRODUCTION:

6[A ceramic is an inorganic non-metallic solid made up of either metal or non-metal compounds that have been shaped and then hardened by heating to high temperatures. In general, they are hard, corrosion-resistant and brittle.Dr Ian Brown, a senior research scientist with an Industrial Research Limited, explains how the term 'ceramics' now has a more expansive meaning. "Traditional ceramics are clay-based, but high-performance or advanced ceramics are being developed from a far wider range of inorganic non-metal materials. Advanced ceramics have the properties of high strength, hardness durability and toughness".]6

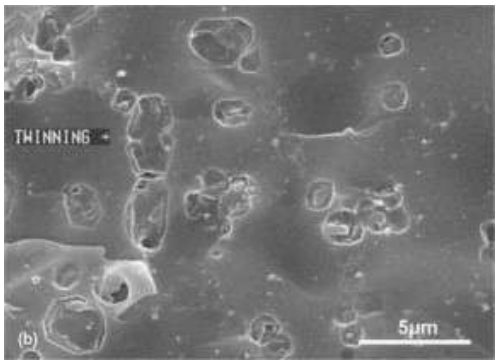
1[Current applications of ceramics in dentistry include fillings, crowns, veneers, implants and dental brackets]1

Fillings

COURTESY:CEREC CERAMIC FILLINGS SUBIACO DENTAL PRACTICE

1[Traditionally filling have been made from silver/tin/mercury amalgams.But Nowadays, resin based filling materials are rapidly gaining in popularity for health and aesthetic aspects. These resins are usually filled with 35-85% ceramic fillers such as silicate glasses, colloidal silica or quartz. Despite the advantages of using ceramic filled resins, these materials may be susceptibe to wear when applied to chewing surfaces.

For this reason, all-ceramic inlays, onlays and crowns are also gaining popularity. CAD-CAM systems are also growing more popular and allow dentists to machine dental ceramic blanks to suit individual patients and fit them in the same visit. Materials that are suitable for this application include:



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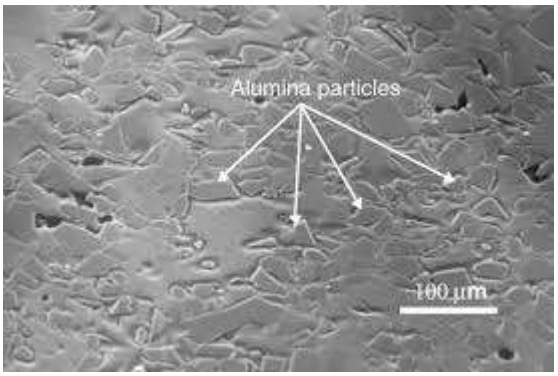
- Leucite reinforced feldspathic porcelain

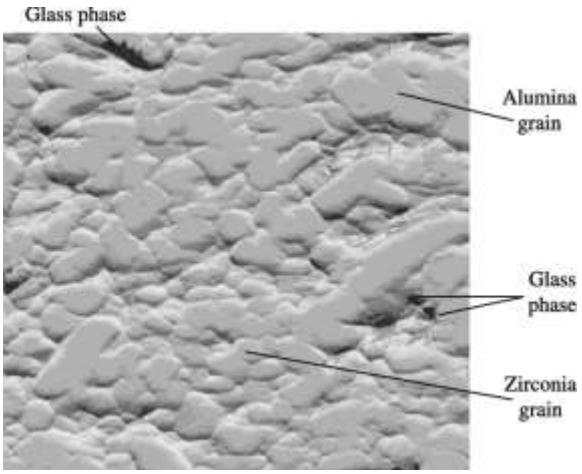
Courtesy:https://www.sciencedirect.com/topics/medicine-and-dentistry/leucite

- Alumina with continuously interconnected porosity, infiltrated with lanthanum aluminosilicate glass, after machining to provide translucency



Courtesy:https://pocketdentistry.com/3-6-all-ceramicrestorations-high-strength-core-ceramics/

Glass infiltrated porous spinel



Courtesy:https://www.researchgate.net/figure/AFM-image-of-a-glass-infiltrated-alumina-zirconia-matrix_fig1_250029408

- Glass infiltrated porous zirconia

Crowns and Veneers

Courtesy:https://www.aestheticsmilereconstruction.com/2020/04/15/everything-to-know-about-porcelain-veneers-and-crowns/

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Porcelain fused to metal (PFM) materials constitute about 75% all crowns in a market consuming about 30 million crowns in the USA. The porcelain used is a feldspathic porcelain. The porcelain contains varying amounts of crystallised leucite. The amount of crystallised leucite influences properties such as strength and thermal expansion. Thermal expansion is critical in the manufacture PFM implants to avoid cracking of the ceramic, which could lead to failure during manufacture or in operation.

PFM materials are also used in veneers to cover damaged front teeth and crowns, although ceramic cores werebeing used in some crowns. All ceramic crowns were usually coated with porcelain to maintain colour and transclucency ,to be matched.

Dental Implants

Courtesy:5 Reasons to Choose Dental Implants by Dental Care of Vashon published May 10, 2019 by Dental Care of Vashon

Dental implants were used as an alternative to bridges where a tooth had been lost or removed. These were also made of PFM, where a biocompatible metal post made out of a material such as titanium was anchored into the jaw bone and the porcelain crown was affixed to the post.

The most recent use for ceramics in dentistry has been orthodontic brackets. The development and demand for these items has been driven mainly by aesthetics. Polycrystalline alumina has been the material of choice in this application.]1

5[Recent advances in Dental Ceramic Technology

1. There has been a rapid diversification in equipment and materials available for computer-aided design/computer-aided manufacturing (CAD-CAM) of ceramic prostheses.
2. The availability of CAD-CAM processing permitted the use of polycrystalline zirconia coping and framework materials. The relatively high stiffness and good mechanical reliability of partially stabilized zirconia allowed thinner core layers, longerspans of bridge, and the use of all-ceramic fixed partial dentures (FPDs) in posterior teeth Basic science researchers were increasingly using clinically relevant specimen geometry, surface finish, and mechanical loading in their in vitro studies. This implied that in vitro results would more accurately predict clinical performance of ceramic prosthesis, but clinicians still need to be cautious in extrapolating from the laboratory to the clinical situation]5

8[1.Powder Condensation
2.Slip Casting
3.Hot Pressing

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4.CAD-CAM]8

2[Different types of dental ceramics based on their composition, processing techniques, properties and clinical applications.

Material
Phase
Processing technique
Physical properties
Clinical applicatins

Feldspathic porcelain
Amorphous glassy phase
Powder slurries for layering and sintering technique
σ: 60-70 MPa;
K_{IC}: 0.9-1.2 MPa·$m^{1/2}$ E:70 GPa; H:6 GPa;
CTE:vary, depends on application
Resin-bonded laminate, metal and ceramic veneer cores
Reinforced feldspathic porcelain
Alumina, leucite, fibres glass dominated phase
Powder slurries for layering and sintering technique or hot press
σ:120-150 MPa;
K_{IC}: 1.5 MPa·$m^{1/2}$; CTE: vary, depends on type of core materials
Resin-bonded laminate, crown and bridges veneers
Leucite glass ceramic (IPS) Empress
$KAlSi_2O_6$ Tetragonal phase
Hot press
CAD/CAM
σ:160 MPa;
K_{IC}: 1.3 MPa·$m^{1/2}$ E:65 GPa;
H: 6.2 GPa;
CTE: 16.6-17.5×10^{-6} K^{-1} (100-500^oC)
Resin-bonded laminate, veneer, crown, onlays and inlays
Lithium disilicate glass-ceramic
Empress 2
$Li_2Si_2O_5$
Long needle-like crystals
Hot press
CAD/CAM

σ: 360-400 MPa;
K_{IC}: 2.2-2.7 MPa·$m^{1/2}$ E: 95 GPa;
H: 5.8 GPa;
CTE: 10.5×10^{-6} K^{-1} (100-500^oC)
Resin-bonded laminate, veneer, onlays inlays, crown and anterior bridge
Fluor-mica
glass-ceramic (Dicor)
$K_2Mg_5Si_8O_{20}F_4$
Glass dominated
phase
Castable
CAD/CAM
σ:150 MPa;
K_{IC}: 1.4-1.5 MPa·$m^{1/2}$ E:68 GPa;
H: 3.3-3.5 GPa;
CTE: 6.4-7.2×10^{-6} K^{-1}
Resin-bonded laminate, anterior crown and posterior inlays]2

4[CAD/CAM RESTORATIONS CAD/CAM—computer aided design/computer aided manufacture. This is a high-tech approach to providing patients with durable tooth-coloured restorations. It involves recording an optical impression from which a restoration can be designed using a computer. The design elements are then used to construct the restoration using a milling machine which cuts the desired shape of a monolithic block of ceramic under the control of the computer. The design of the restoration on the computer screen takes between 10 and 25 minutes depending on the complexity of the restoration and the extent of the patient's occlusal correction. The milling process takes 5–10 minutes. CAD/CAM dental equipment 20 A CAD/CAM equipment for manufacturing dental appliances and restorations at the chair-side using computer-generated images and computer controlled milling equipment is shown on the figure 17. There are the control unit and the computer used for viewing the scanned images on the right of the figure and there is a milling machine in which the shapes are cut of a variety of materials on the left.]4

7[ADVANTAGES AND DISADVANTAGES OF CAD/CAM Advantages:

1. Reduced chairside time.
2. Stronger porcelain. Milled ceramic is highly strong.
3. In some systems the scanning is done directly in the mouth so there is no necessity to make an impression.
4. Single visit procedure.
5. Lab equipment can be minimized as the equipment involved with metal casting and processing are not required.
6. The possibility to copy the original form of the tooth ,enables the dentist to duplicate a pre-prepared tooth.

Disadvantages:

1.Equipment is expensive.
2. The technique is scanning sensitive (there may be many errors).
3. The lack of computer software to control the occlusal adjustment]7

3[All-Ceramics

Increasingly, the spotlight continues to be focused on all-ceramic restorations. The challenge lies in offering the best possible solution that meets the

requirements of the individual clinical situation and the aesthetic expectations.

The tried-and-tested IPS Empress leucite glass-ceramic provided key impetus to aesthetic dentistry in the nineties and it has never lost its importance. Now the innovative IPS e-max all-ceramic system incorporates several new types of materials: lithium di-silicate, flour -apatite and zirconium oxide glass-ceramics. The lithium di-silicate ceramics are suited for both the press technique and CAD/CAM applications. They are available in several degrees of translucency, providing a maximum level of aesthetics – but not only that: Given their high strength (500 MPa*), the IPS e-max lithium di-silicate ceramics can be used for a broad range of indications.

* mean biaxial flexural strength over 10 years (IPS e-max CAD 530 MPa, IPS e-max Press 470 MPa).]3

II. CONCLUSION:

Ceramic has been a promising result in terms of material use in dentistry and is a promising material of choice in the ages to come,with further advancements in technology

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