Lecture 4
All ceramic crowns

By Dr Cheryl Fu

Learning objectives

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- Advantages and disadvantages of ceramic crowns
- Different types of ceramic crowns
- Ceramic materials

Readings:

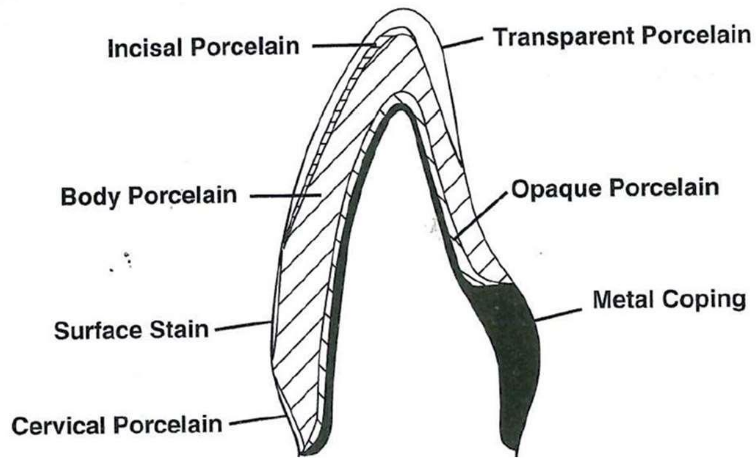
Bajraktarova-Valjakova E, Korunoska-Stevkovska V, Kapusevska B, Gigovski N, Bajraktarova-Misevska C, Grozdanov A. Contemporary dental ceramic materials, a review: chemical composition, physical and mechanical properties, indications for use. Open access Macedonian journal of medical sciences. 2018 Sep 9;6(9):1742.

Contemporary fixed prosthodontics: Chapter 25 All ceramic restorations

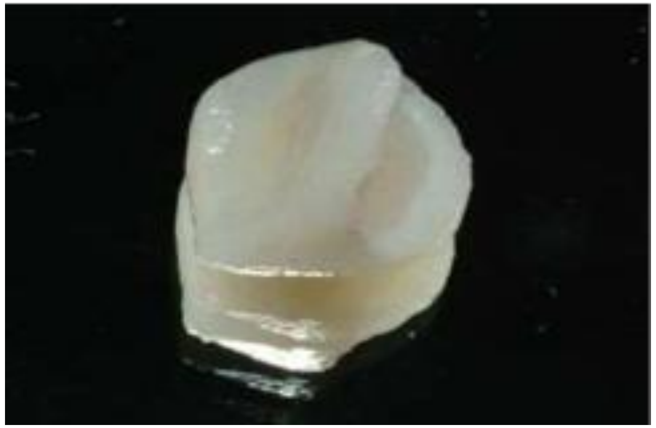
So ceramic crowns?

Limitations of PFM crowns:

- Aggressive reduction
- Not as aesthetic (opaqueness)
- Potential biocompatibility issues with metal sensitivities /allergies.



Ceramic crowns



Very natural appearance!

Slide by Dr Nedelcu

Ceramics vs porcelain

- Ceramic is a compound of metallic elements (eg, aluminum, calcium, lithium, magnesium, potassium, sodium, tin, titanium, zirconium) and non-metallic elements (eg, silicon, fluorine, boron, oxygen)
- Porcelain is a ceramic consisting of a glass matrix phase and one or more crystalline phases (eg, leucite).
- All porcelains are ceramics, but not all ceramics are porcelains.

Classification of Dental Ceramics

An understanding of dental ceramic classifications enables the clinician to provide the optimum in strength and esthetics

By Gregg A. Helvey, DDS

Ceramics

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Glassy vs Crystalline

- Glassy phases in ceramics are important for aesthetics.
- Crystalline ceramics are extremely strong but often lead to poor aesthetics.

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Dental Ceramics

Classification of Dental ceramics:

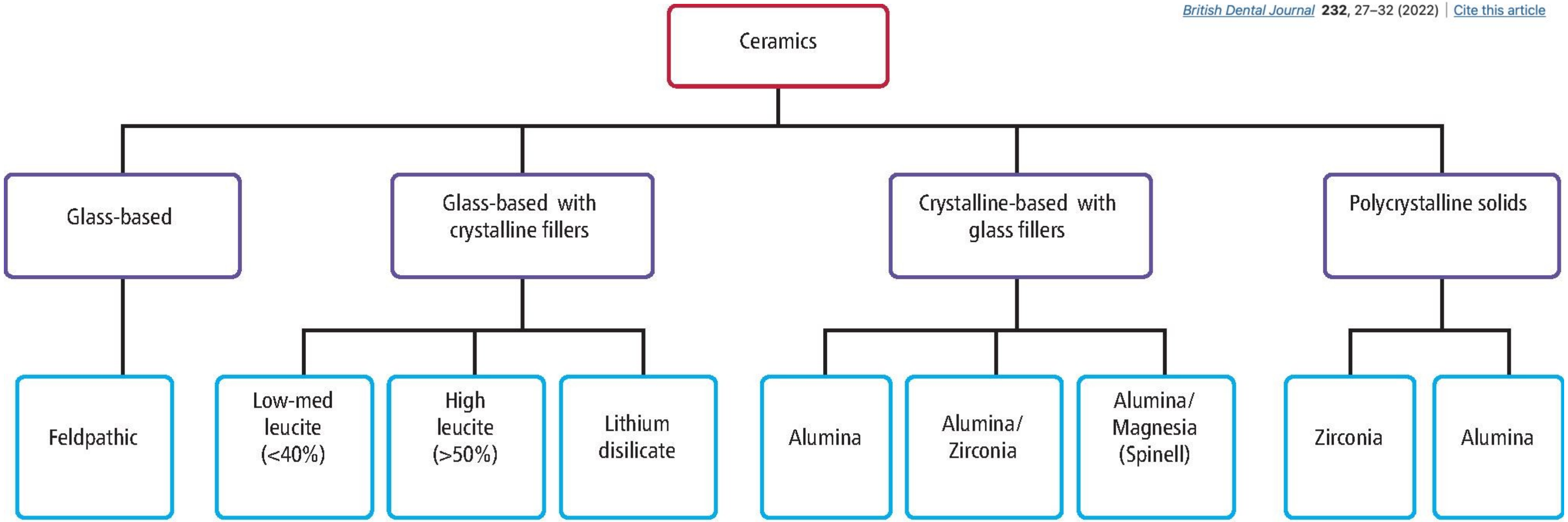
- **Composition**
- Processing manner

Many classification methods

Do you know your ceramics? Part 1: classification

Mojgan Talibi, Kiran Kaur, Hussein S. Patanwala & Hit Parmar

British Dental Journal **232**, 27–32 (2022) | Cite this article



+resin matrix ceramics

Dental ceramics: Composition

Composition:

- Glass based ceramics
  - Feldspathic ceramics: Mainly composed of feldspar and also quartz, potash (K_2O) and various metal oxides
  - Very aesthetic due to mainly glass based ceramic, however often strengthened with some leucite.
  - Used as monolithic ceramic for single-unit anterior prostheses, veneers, inlays or onlays. However can use to veneer other ceramics.
  - Slurry method
  - Adhesively cemented due to lower flexural strength
  - Flexural strength
    - Pure feldspathic: 50-80 Mpa
    - Leucite reinforce: ~160MPa
  - CAN ETCH

Dental ceramics: Composition

Composition:

- Glass based (with crystalline fillers)
  - Leucite reinforced glass ceramics.
    - Leucite is a crystalline mineral formed when feldspar is melted.
    - Good aesthetic properties.
    - Leucite based ceramics are usually processed via “hot pressing”.
    - “dispersion strengthening”: process by which the dispersed phase of a different material (in this case it is leucite in a glass matrix) is used to stop crack propagation, since these crystalline phases are more difficult to penetrate by cracks. (Eg. IPS Empress CAD)
  - Lithium disilicate reinforced glass ceramics. It also formed an intertwined structure after heat pressing, which also aids in increase of fracture strength. Alternatively it can be milled whilst in an intermediate crystalline phase and then tempered at high temperatures to harden it fully. (Eg. IPS Emax CAD) Suited for single unit anterior crowns due to flexural strength of 360-400MPa.
  - Zirconia reinforced lithium silicate. Similar to above but also has zirconica dispersed into the glassy matrix. This gives it a higher flexural strength of 460 MPa (Eg. VITA Suprinity)
  - CAN ETCH

Dental Ceramics: Composition

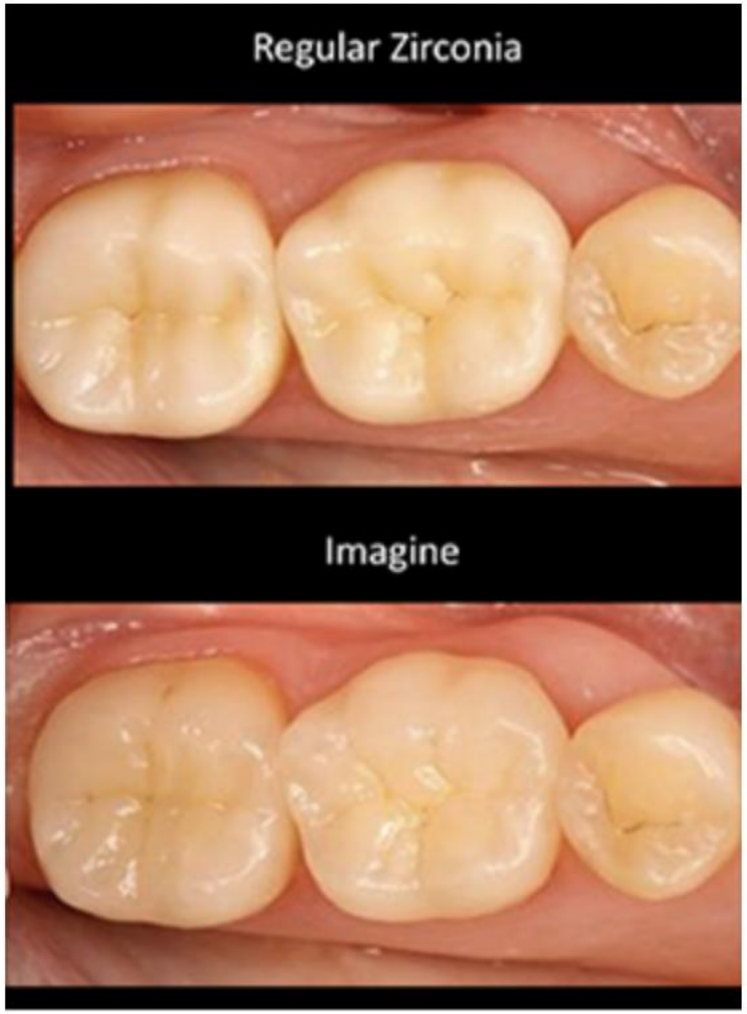
Glass infiltrated ceramics:

- Requires a porous crystalline “skeleton” that is infiltrated with a glassy phase.
- Associated with slip casting
- Eg (VITA In ceram Alumina, VITA In ceram Spinell, VITA In ceram Zirconia)
- However very hard to make, and thus has lost popularity.
- CANT ETCH

Dental Ceramics: Composition

Polycrystalline ceramics:

- Alumina: High flexural strength 500MPa-700MPa
- Zirconia (covered in next slide)
- Can not be etched
- Zirconia can be used for a wide variety of indirect restorations such as crowns, bridges etc.
- Can be found as monolithic zirconia crowns, or veneered zirconia crowns.
- Initially zirconia was very opaque and not suited for anterior crowns. However high translucency zirconia also available now.



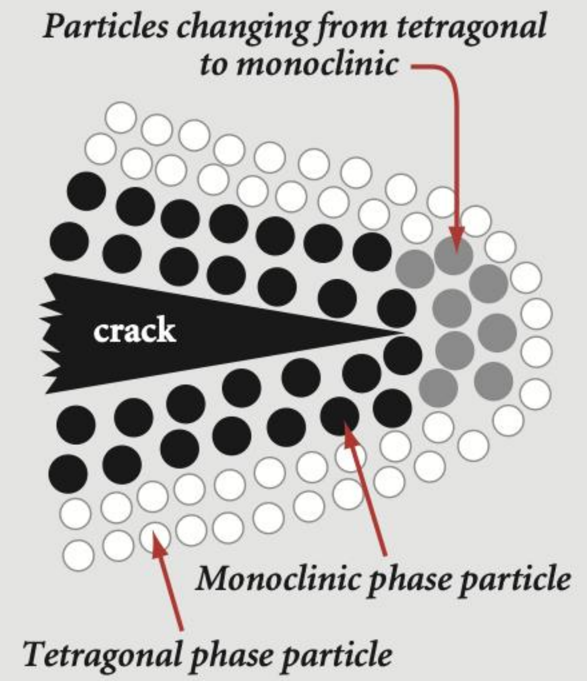
Source: Jensen Dental

Dental Ceramics

Zirconia:

- Scientifically termed zirconia dioxide, it has fantastic chemical and stability, mechanical strength and elastic modulus similar to stainless steel.
- The flexural strength ranges from 900MPa to 1200MPa.
- Zirconia has a unique feature called "**transformation toughening**". Zirconia may have 3 forms (monoclinic at room temp, tetragonal at 1200C and cubic at 2370C). Yttira is used to stabilize zirconia so it can maintain the tetragonal form at ROOM TEMP. When a crack forms zirconia phase changes from tetragonal to monoclinic. During transformation to monoclinic form there is an associated 3-5% volumetric increase, generating compressive forces around the crack, countering the tensile forces at the tip of the crack line.

FIG. 16



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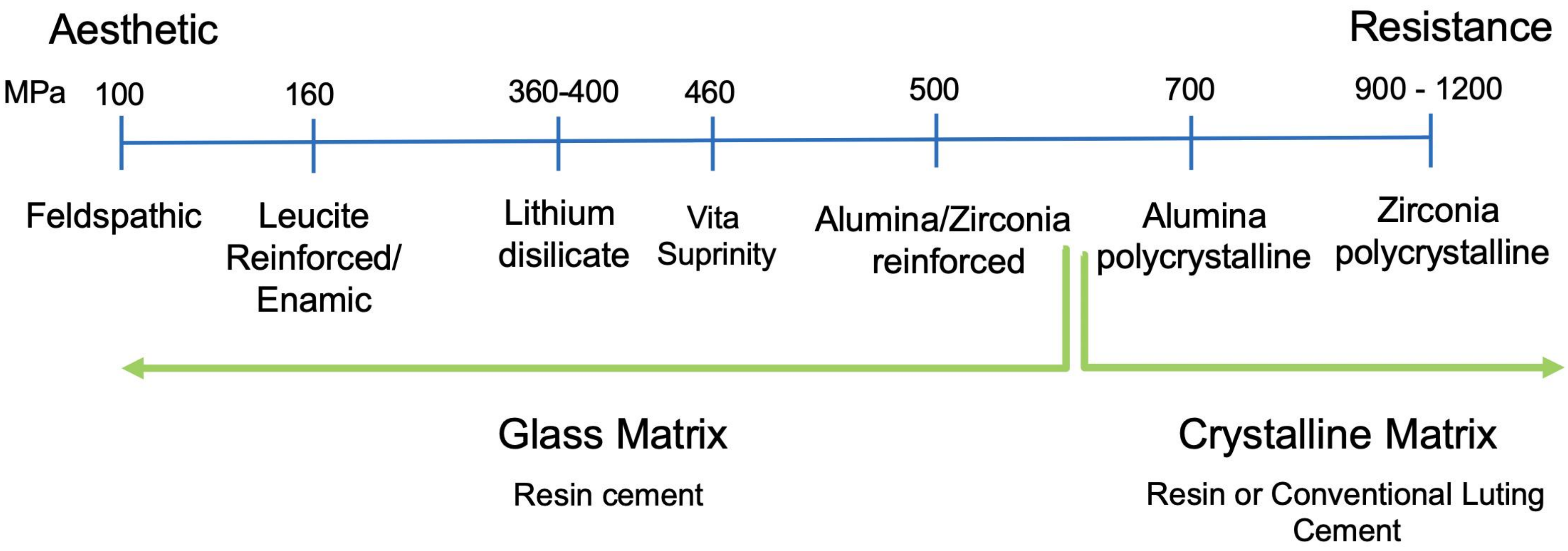
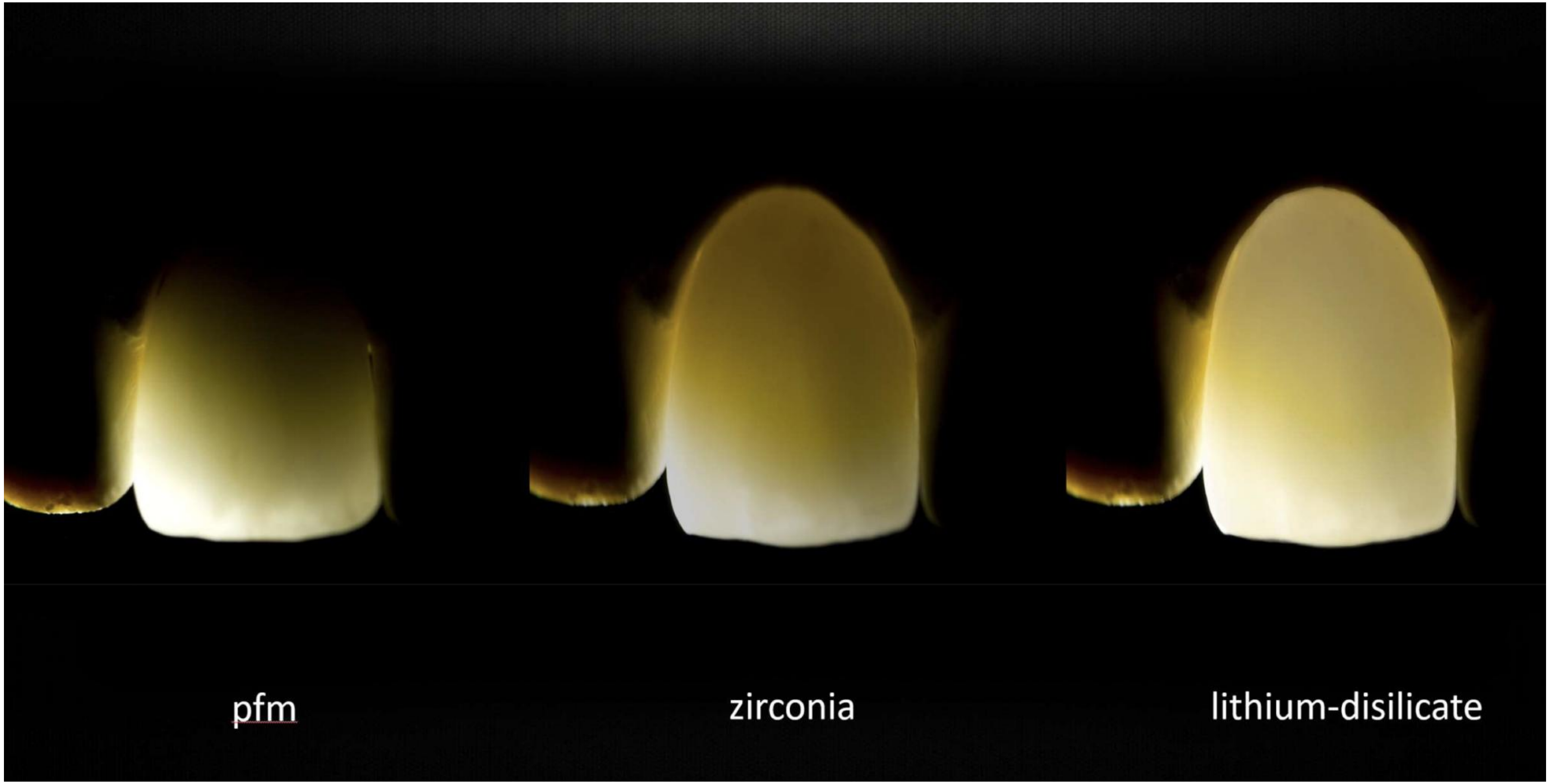
Dental ceramics



Slide by Dr Matsubara and Dr Nedelcu

Dental ceramics



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Dental Ceramics

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Resin matrix ceramics:

- Eg Lava Ultimate, VITA Enamic
- Hybrid ceramics: Nanoceramic particles in a high crosslinked polymeric matrix.
- Due to the resin polymeric matrix the material is no brittle and as good shock absorbing characteristics.
- Lava is not recommended for crowns, but can be used for inlays/onlays. Enamic can be used for posterior and anterior crowns too.
- No need to fire or sinter like other ceramics.

Dental Ceramics

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Classification of Dental ceramics:

- Composition
- **Processing manner**
  - Powder/Liquid building
  - Slip casting
  - Hot ceramic pressing
  - CADCAM

Many classification methods

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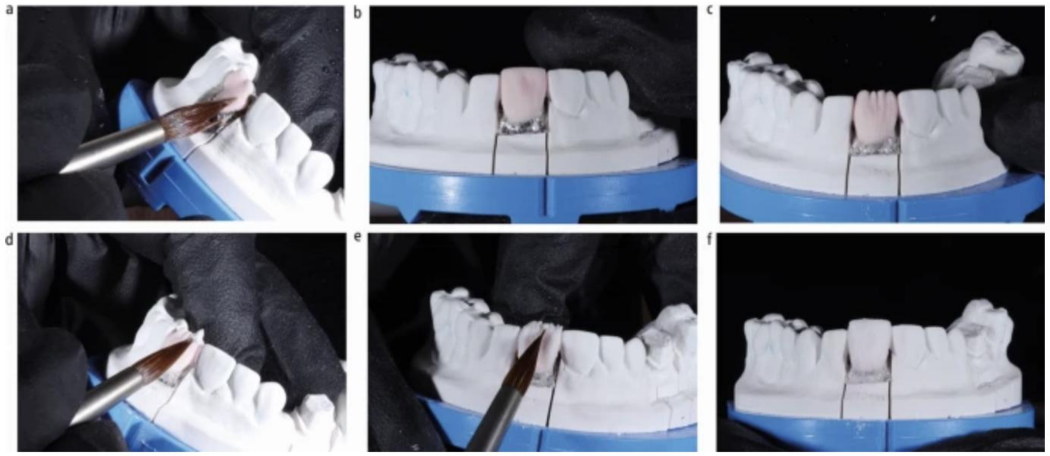
Fig. 1



a, b, c, d, e, f) Layering and manipulation of feldspathic slurry to achieve the desired optical results

Powder/Liquid building:
Uses a ceramic powder and liquid to form a “slurry”. This can then be painted onto a metal or ceramic layer. This is very technically demanding for the dental technicians and poor techniques can result in weaking of the restoration if porosities/voids are created. The ceramic coated crown is fired (known as sintering) to solidify and fuse the ceramic particle together.

Usually used for feldspathic

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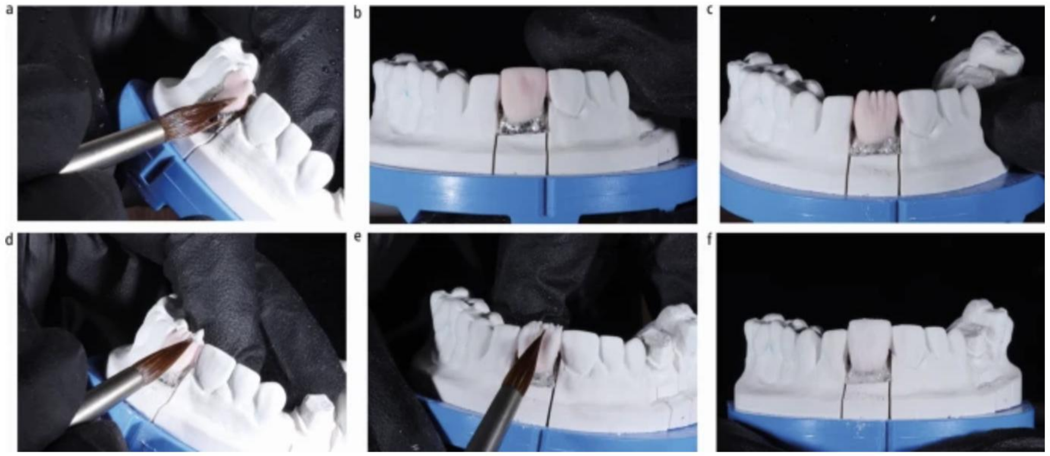
Fig. 1



a, b, c, d, e, f) Layering and manipulation of feldspathic slurry to achieve the desired optical results

Advantages: Highly translucent and aesthetic. Allows for good control over the shades and can be customized to a large degree.

Disadvantages: Weak, shrinkage during firing, porosities from technique sensitivity. Requires a skilled technician!

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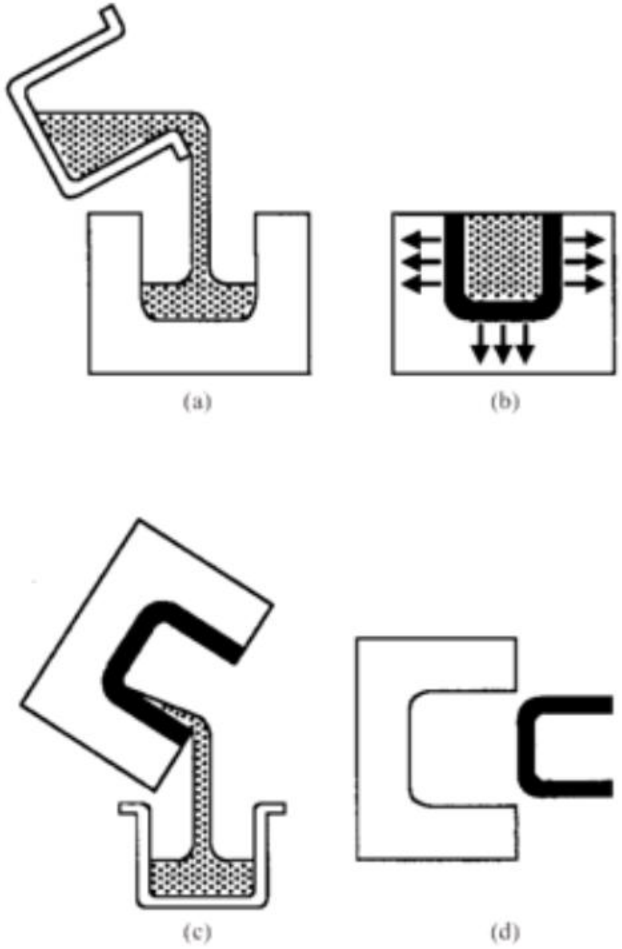
Colloid Casting

C.H. Schilling



Slip casting:
Utilised a porous die is dipped into a slurry made of fine ceramic particles. After absorption of the water particles by the porous die, a thin layer of the slurry material remains on the die. This is then fired, and due to shrinkage of the die, the porous core is able to be easily removed. This structure is then infiltrated by molten glass.

Used in manufacturing of: In ceram family

Dental Ceramics

Classification of Dental ceramics:

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  - **Hot ceramic pressing**
  - CADCAM

Hot ceramic pressing
The dental technician creates the restoration in wax, and using the lost wax technique, an investment mold is created. A plasticized ceramic ingot is pressed into the heated investment mold to create the final restoration.

Usually used for leucite based glass or lithium disilicate

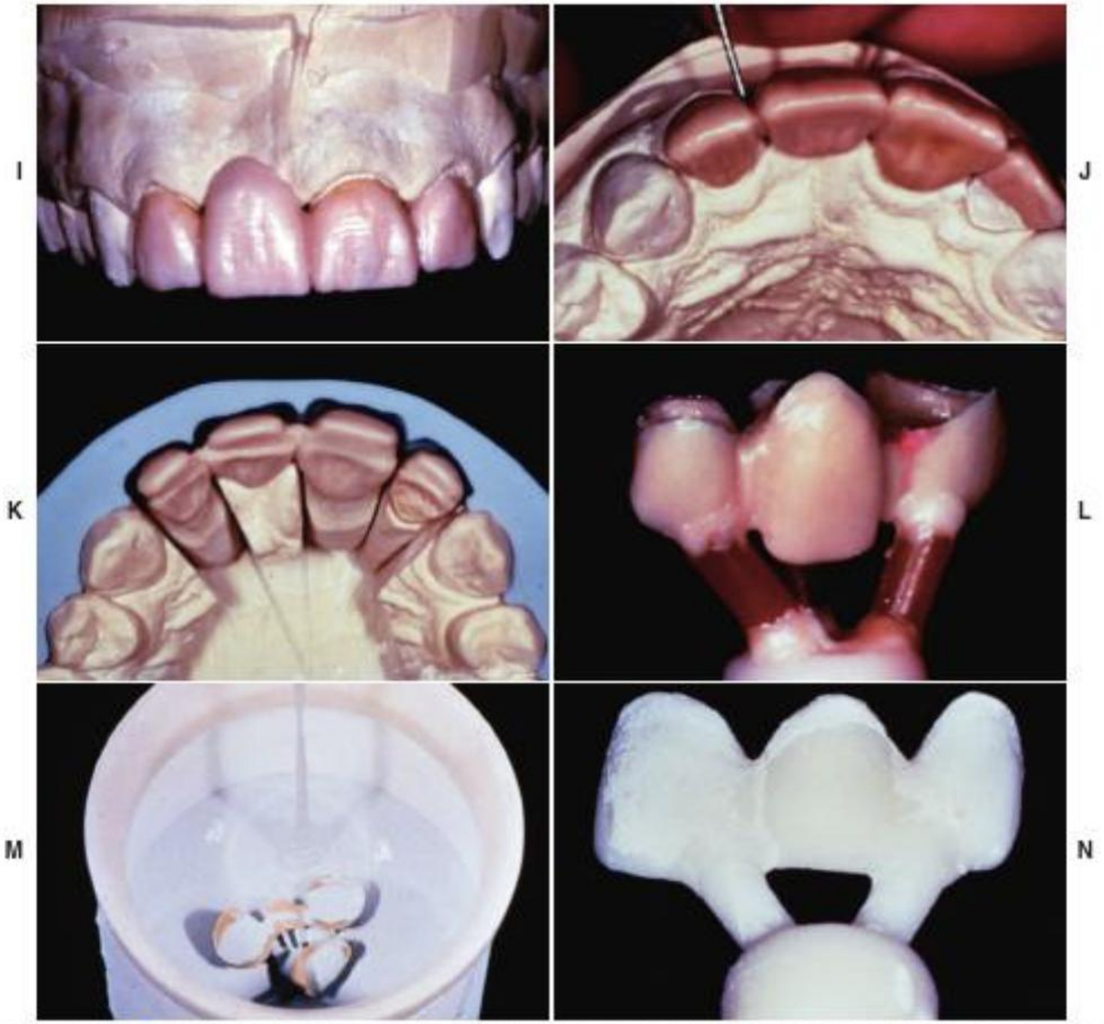

FIGURE 25-6, cont'd **I,** Three-unit fixed dental prosthesis and veneer waxed to anatomic contour. **J,** The technician ensures that the connector size is adequate (4 × 4 mm). **K,** A silicone putty matrix is used to aid in cutback of the wax pattern. The sprue is inserted into the framework **(L)**, the framework is invested **(M)**, and the lithium-silicate ceramic is pressed into the mold. **N,** The pressed restoration.

Continued

Classification of Dental ceramics:

- Composition
- **Processing manner**
  - Powder/Liquid building
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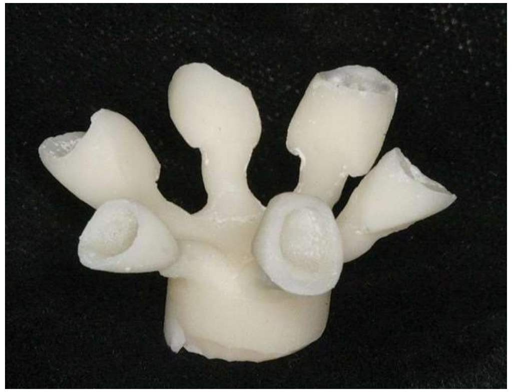

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Usually used for leucite based glass or lithium discillicate

FIGURE 25-6 Heat-pressed ceramic technique. **A,** Ceramic inlay restoration for a maxillary molar. A wax pattern is made in a manner similar to that for conventional gold castings. **B,** After the pattern is invested, it is burned out, and a ceramic ingot and an alumina plunger are placed in the heated mold. **C** and **D,** The pressing is done under vacuum pressure at 1165°C. **E,** The sprue is removed. **F,** The pressed restoration is seated on the die. **G** and **H,** For esthetic anterior restorations, only the dentin-colored ceramic is pressed. The incisal porcelain is applied by brush in the conventional manner.

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FIGURE 25-7, cont'd ■ **I,** Completely milled extracoronal restoration. **J,** Restoration on firing tray before firing to transform the lithium metasilicate into lithium disilicate. On firing, the restoration achieves its desired appearance. **K** and **L,** Completed crown. (**A** to **D** and **H** to **L,** Courtesy Dr. R. Fox, Sirona Dental Systems, Inc., Charlotte, North Carolina. **E,** Courtesy VITA North America, Yorba Linda, California. **F,** Courtesy Ivoclar Vivadent, Amherst, New York. **G,** Courtesy 3M ESPE Dental, St. Paul, Minnesota.)

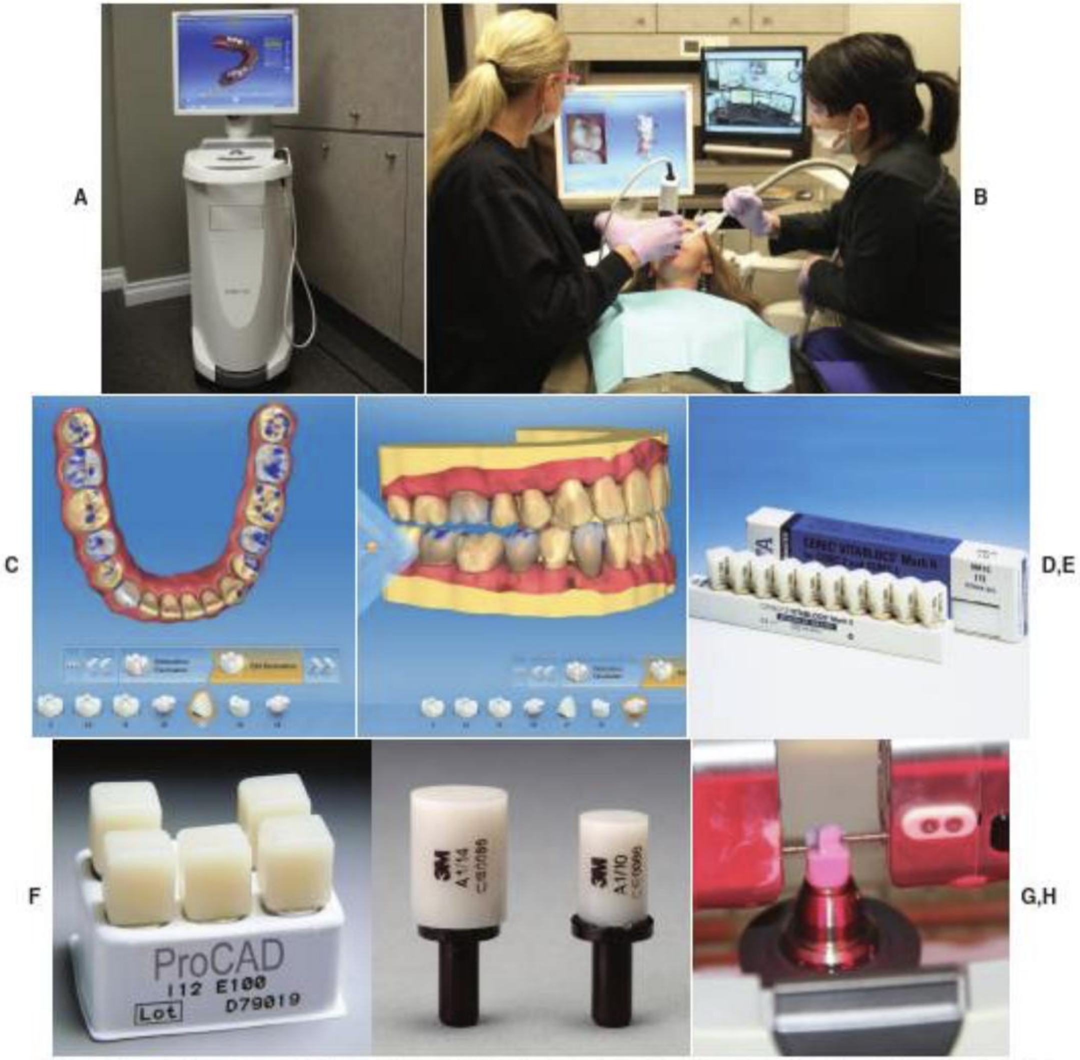

FIGURE 25-7 ■ Cerec Omnicam computer-assisted design/computer-assisted manufacturing (CAD/CAM) system. **A,** The Cerec Omnicam system consists of an imaging system, a computer, and a milling system. **B,** Making an optical impression. **C,** A number of computer-assisted designs for extracoronal restorations are available. **D,** The software enables simulated mandibular movements to help evaluate that the desired occlusal structure is approximated. **E-G,** Blocks are available in different ceramic systems, as is composite resin. **H,** Milling of a blue, translucent-state lithium disilicate crown in progress. *Continued*

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CADCAM

Computer aided design and computer aided manufacture. Additive CADMCAD machines exist, but mostly subtractive machines are used (such as here in OHCWA). Ceramic blocks are milled into appropriate shapes, then fired in the oven. This is especially required for zirconia blocks. Due to the high strength of zirconia, ”green” pre-sintered zirconia blocks with porosities are milled whilst they are still softer than “white” fully hardened zirconia. They are then fired at high temps (1300C+) to densify the zirconia to the crowns we receive from the lab. Due to shrinkage the zirconia crowns need to be milled larger than the final restoration dimensions. It is also possible to mill “white” hardened zirconia, but very time consuming and causes a lot of wear to the milling burs.

Dental Ceramics

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Advantages:

- Simplified fabrication method
- More durable material application
- Homogeneous material
- Superior accuracy
- Chair-side option is available

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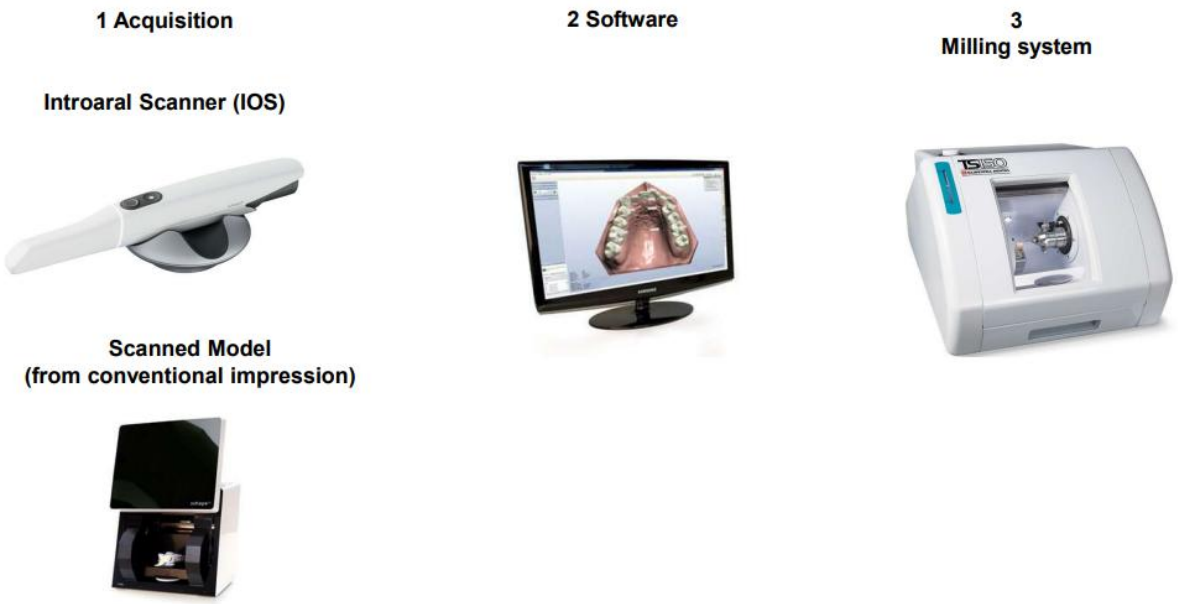

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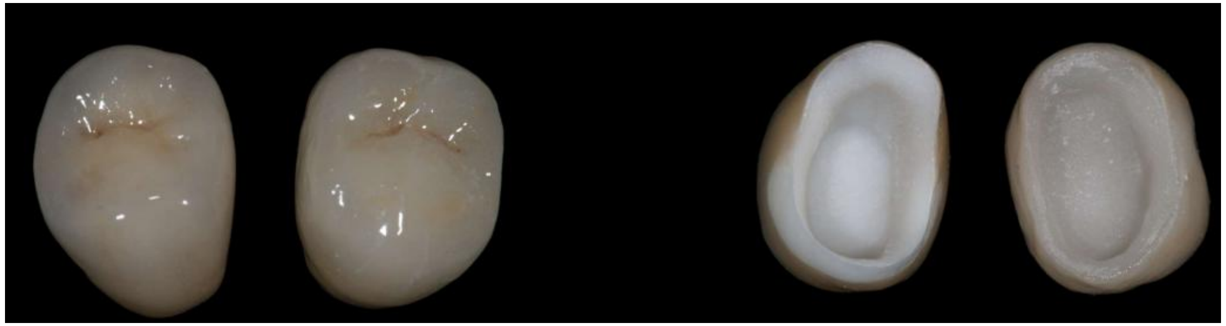


Cut back and layer

External shading

Dental Ceramics

TAKE HOME MESSAGE:

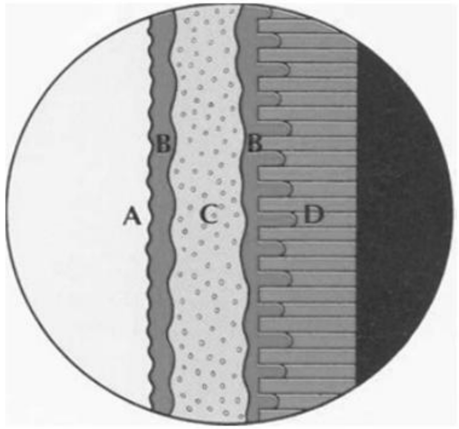
- Some ceramics CAN be etched with hydrofluoric acid (~9%) to increase retention (Suprinity, Emax, Enamic) and cemented adhesively with resin-based cements. These ceramics are predominantly GLASSY ceramics.
- Some ceramics CAN NOT be etched with hydrofluoric acid (zirconia) because they DO NOT contain glassy phases (they are CRYSTALLINE). They will require luting cements in conjunction with internal sandblasting, or other chemical agents such as MDP containing cements .

Resin Cements

- We will talk more about cements in the later lectures
- Briefly:
  - Resin cements strengthen the ceramic material
  - Prevents internal crack propagation
  - Increase restoration interface strength
- Silane
  - Establishes covalent bond between ceramic surface and composite resin
  - Improves wetting of ceramic by composite resin cement

Adhesive Cementation – Resin cements

A. Etched and silane on ceramic
B. Bonding agent
C. Composite resin cement
D. Etched enamel



Slide by Dr Matsubara and Dr Nedelcu

Ceramic crown advantages and disadvantages

Advantages:

- Superior aesthetics (some better than others)
- Biocompatible
- Chemically inert
- High hardness and other mechanical properties (certain ceramics)

Disadvantages:

- Some ceramics have poor mechanical properties
- Brittle if unsupported (not to exceed 2mm)
- Technically demanding
- Possibly more tooth structure reduction required

Ceramic Crowns

Indications:

- High aesthetic demand
- Metal allergy
- More conservative than PFM

Contra-indications:

- Heavy bruxers
- Heavy occlusal forces
- Parafunctional habits
- Overly short clinical crowns

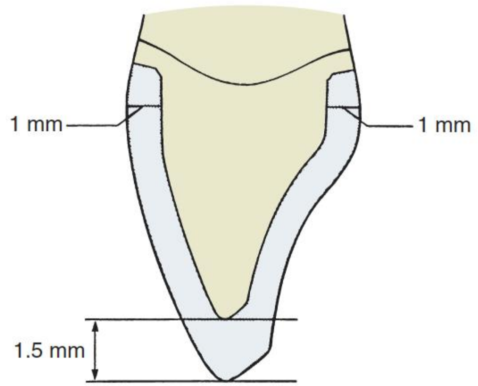


FIGURE 11-1 ■ Recommended reduction for all-ceramic crowns.

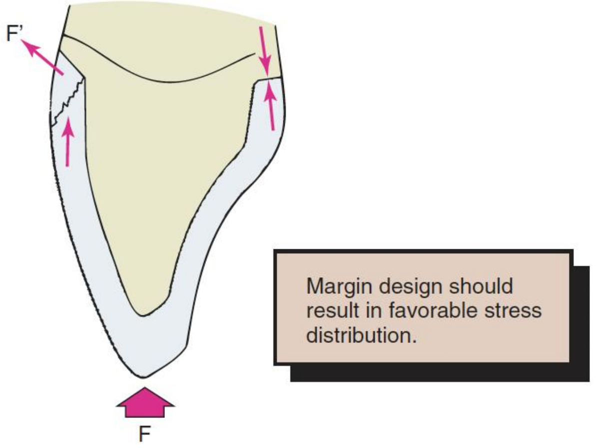
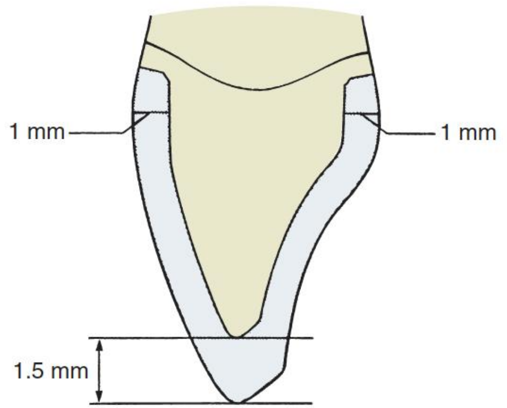


FIGURE 11-2 ■ A sloping shoulder margin is not recommended for the all-ceramic crown. It does not support the porcelain. Incisal loading leads to tensile stresses near the margin if the forces are not reciprocated *(arrows)*, which may cause brittle failure. *F,* Force.



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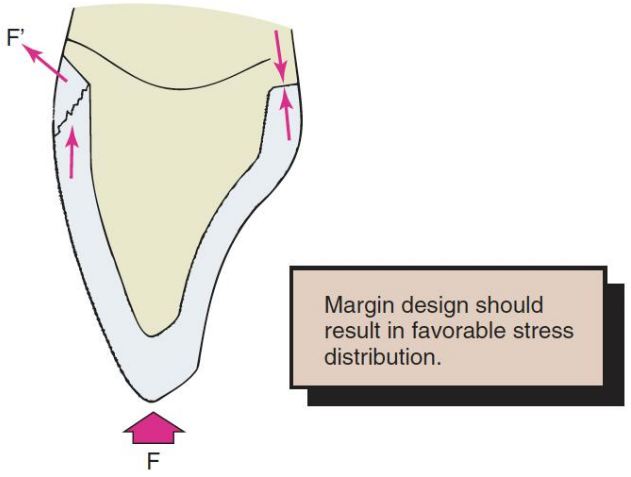

FIGURE 11-2 ■ A sloping shoulder margin is not recommended for the all-ceramic crown. It does not support the porcelain. Incisal loading leads to tensile stresses near the margin if the forces are not reciprocated *(arrows)*, which may cause brittle failure. *F,* Force.

Thanks for listening!

Any questions?