Dental Ceramics I

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Francis Bacon Sr.

- **"Read not to contradict and confute, nor to believe and take for granted, but to weigh and consider . . . Histories make men wise."**

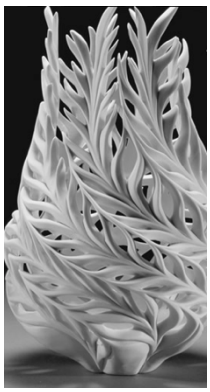
Aim & objectives

- Chemistry
- Types
- Properties
- Production methods

- "A ceramic so white that it was comparable only to snow, so strong that vessels needed walls only 2-3 mm thick and consequently light could shine through it. So continuous was the internal structure that a dish, if lightly struck would ring like a bell.

This is porcelain!"

Marco Polo



Historical background

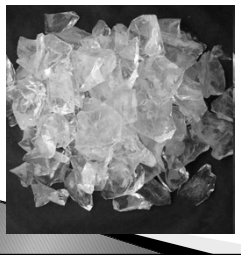
- Domestic china stoneware, 100 BC
- Europe 1717
- Alexis Duchateau , porcelain denture teeth
- Fonzi, porcelain for individual teeth
- Charles Land, Feldspathic porcelain jacket crown.
- Leucite and porcelain fused to metal, 1950s
- Alumina jacket crowns, 1960
- CAD/CAM systems 1980-
- Alumina crowns, 1990-
- Zirconia, 2000-
- Alumina-Zirconia ceramic composite (Ink)

Composition of dental porcelain

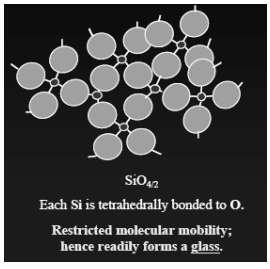
- Vitreous silica.
- Network modifiers: Feldspars, Potash ($K_2O.Al_2O_3.6SiO_2$) & Soda ($Na_2O.Al_2O_3.6SiO_2$) and Leucite ($KAl_2Si_2O_2$)
- Net forming oxides:(Al_2O_3 and B_2O_3)
- Opacifecent oxides :(ZrO, SnO_2),.
- Fluorescent oxides: (CeO_2).

Porcelain

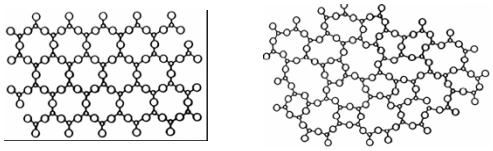
Feldspathic glass and finely ground quartz



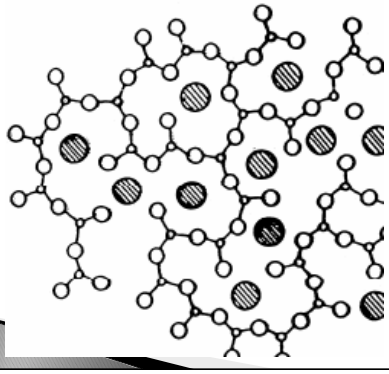
Silica structure



Glassy Vs crystalline structures



The network modifiers



Ceramics

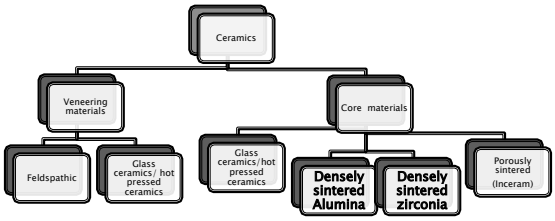
Types

1- Predominantly glass materials.

2- Particle filled glasses.

3- Polycrystalline

- Types of ceramics



Ceramics- Predominantly glass

- Feldspathic porcelain; Veneering porcelain

e.g.: Ceramco, VM7, VM13, Vitadur
The highest aesthetic quality

Ceramics-particle filled glass

- Cast-Glass Ceramics
- Luecite reinforced/Lithium di-silicate (Hot Pressed)

Ceramics-Polycrystalline

- Alumina & Alumina Spinell (Porous and Densely sintered)
- Zirconia (Inceram Zirconia and Yttriumoxide Tetragonal Polycrystals YTZP Zirconia)

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Ceramics-Methods of fabrication

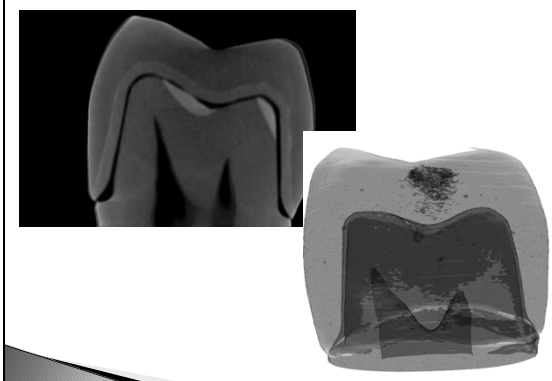
- Sintering
- Ceramming
- Pressing
- Machining (CAD/CAM and Copy Milling)

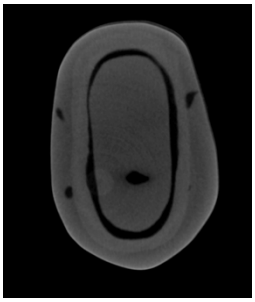
Properties of dental ceramics

- Biocompatibility:
  - Inert material
  - Glazed surface.
  - Colour maintenance

Mechanical properties

- Brittle material
- Much stronger in compression than in tension.
- Strength
  - Multi-factorial
  - Layering technique
  - Machined ceramics (CAD/CAM) higher than lab made
- Fracture Toughness.
  - Material specific
  - Zirconia>Alumina>Feldspathic porcelain





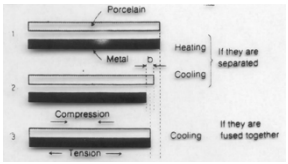
So why do ceramics fracture?

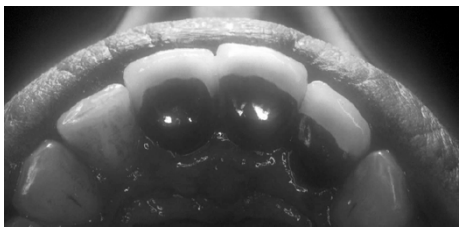
- No movable joints
- Flaws
- Cracks
- Weakening effect of water and cyclic loading

Methods to strengthen ceramics

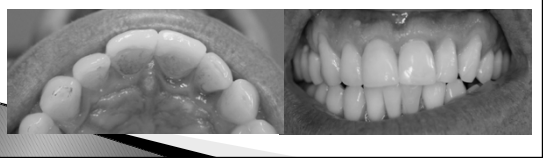
1- Lamination to a stronger substrate (Metal, tooth structure or high strength ceramics)
  - CTE
  - Bonding mechanism
  - Effect on other properties

Methods to strengthen ceramics





Veneers



Methods to strengthen ceramics

2- Dispersion strengthening

- Leucites
- Alumina
- Glass infiltration (Incerams)

Methods to strengthen ceramics

3- To reduce flaws and cracks by
- controlled heat treatment (Ceramming)
- Salt ion crystallisation (K instead of Na)
- CAD/CAM machining

Hardness

- Surface property
- Porcelain should be glazed or finely polished
- Veneering versus core materials

Translucency

Vitadur Alpha dentin

Empress 1

Inceram Spinell

Empress 2

Procera

Inceram Alumina

Inceram Zirconia

YTZP

Heffernan et al JPD 2004

Deal Or No Deal?!!
For this lecture and coming one

- Either I supply you with an extensive reading list

OR

- You pick 2 chapters from 3 DM books (I choose one)
- You pick 3 review articles about ceramics (I choose one)

Be cool