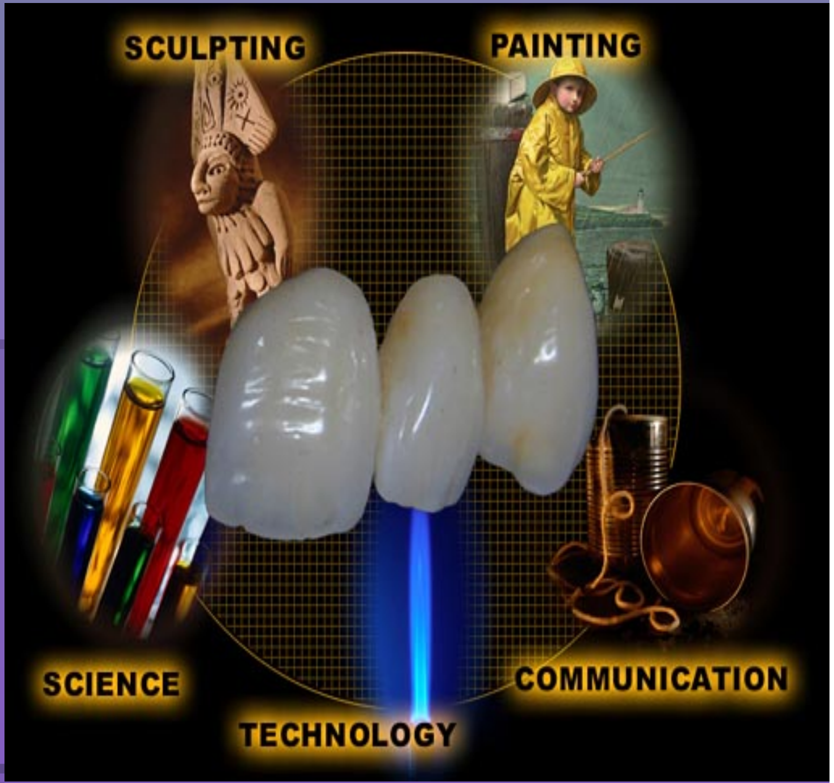
BY: DR. SANJAY LAGDIVE
PROFESSOR, DEPT. OF PROSTHO,
GDCHA.



DENTAL CERAMICS

- **Ceramic** : A compound of metallic and nonmetallic elements.
- **Dental Ceramic** : A compound of metals and nonmetals that may be used as a single structural component, such as when used in a CAD-CAM inlay, or as one of several layers that are used in the fabrication of a ceramic-based prosthesis.

CLASSIFICATION OF DENTAL CERAMICS

- According to their maturation or fusion range:

1. High fusing (1290 to 1370 degree Celsius)
2. Medium-fusing (1090 to 1260 degree Celsius)
3. Low-fusing (870 to 1070 degree Celsius)

- According to type : Feldspathic porcelain, leucite reinforced porcelain, aluminous porcelain, alumina, glass-infiltrated alumina, glass infiltrated spinal and glass-ceramic.

- According to use : For denture teeth, metal-ceramics, veneers, inlays, crowns and anterior bridges.
- According to processing method : sintering, casting or machining.
- According to substructure material : cast metal, swaged metal, glass-ceramic, CAD-CAM porcelain, or sintered ceramic core.

- The metal-ceramic restoration consists of a metal substructure supporting a ceramic veneer that is mechanically and chemically bonded to it. The chemical component is achieved through **firing(baking).**
- **Composition** : Dental porcelain is produced from a blend of quartz, feldspar (potassium aluminium silicate orthoclase, sodium aluminum silicate albite), and other oxides.
- During manufacture, the materials are heated to high temperature to form a glassy mass and then rqpidly cooled by quenching them in water, which causes the glassy mass to fracture. The resulting product is called a **frit**. This process may be repeated several times, after which the frit is ballmilled until the desired particle size distribution is obtained.

- Most formulations designed for metal-ceramic use consist of a mixture of two frits: a low-fusing glass frit and a high-expansion frit consisting of crystalline leucite with a tetragonal symmetry.
- After firing in the laboratory, dental ceramics consist of about 20 percent volume of tetragonal leucite crystals dispersed in a glassy matrix. The structure of this glassy matrix is a random Si-O network. The silicon atom combines with four oxygen atoms in a tetrahedral configuration. These tetrahedra may be linked into a chain with both covalent and ionic bonds, leading to a stable structure. However, such a Si-O network would have a very high melting point. Usually, potassium and sodium are added to the glass composition to help break down the Si-O network and are therfore known as **glass modifiers.**

PORCELAIN TECHNIQUE

- Dental porcelain is usually received from the manufacturer in powder form , which is mixed with either water or a water-based glycerin-containing liquid to form a paste of workable consistency. This mixture is then used to make a restoration with required configuration.
- Several condensation techniques (e.g. vibration and blotting) are used to remove as much excess water as possible.

TYPES OF PORCELAIN

- **Opaque porcelain** : This is applied as a first ceramic coat and performs two major functions : it masks the color of the alloy, and it is responsible for the metal-ceramic bond.
- **Body porcelain** : Body porcelain is fired onto the opaque layer, usually in conjunction with the incisal porcelain. It provides some translucency and contains oxides that aid in shade matching. Body porcelains are available in a wide selection of shades to match adjacent natural teeth.
- **Incisal porcelain** : Incisal porcelain is usually translucent. As a result, the perceived color of the restoration is significantly influenced by the color of the underlying body porcelain.

PORCELAIN-ALLOY BONDING

- The formation of a strong bond between the opaque porcelain layer and the cast alloy is essential for the longevity of the metal-ceramic restoration.
- Early work established the importance of wetting the alloy surface by the porcelain at the firing temperature.
- The model by Borom and Pask considers idealized continuous lattice sturcture across the metal-ceramic interface for chemical bonding. This is achieved by incorporating certain oxidizable elements that become dissolved in the porcelain into the casting alloy composition.
- Manufacturers incorporate in the casting alloy composition small amounts of certain base metals that form oxides and contribute chemical bonding to the metal-ceramic adherance.

FACTORS AFFECTING THE BOND

- Most metal-ceramic systems require that the cast alloy be subjected to an initial oxidation step before the several layers of dental porcelain are fired. **This step has also been called a conditioning bake or degassing.**
- The oxide layer between the metal and ceramic should have an optimum thickness for a strong metal-ceramic interfacial bond.
- Research has shown that particular care is required with the base metal casting alloys to avoid excessively thick oxide layers. Beryllium is added to some Ni-Cr alloy compositions to lower the melting range; beryllium also has an effect on the thickness of the oxide layer.
- Airborne particle abrasion with aluminum oxide is routinely performed on the alloy castings to create surface irregularities and to provide mechanical interlocking with the opaque dental porcelain.

SELECTION CRITERIA

- Most manufacturers of modern dental porcelains specify the alloy systems with which a material is compatible. Usually that compatibility refers to the relative coefficients of thermal expansion.
- **Opaque Porcelain** : For a proper mechanical bond and chemical interaction at the interface, opaque porcelain must wet the surface easily. It becomes the primary source of color of the restoration and must mask the color of the metal, even in thin layers. Opaque thickness generally should not exceed 0.1mm; otherwise, achieving an esthetic result without overcontouring the restoration becomes impossible.
- **Body and Incisal Porcelains** : As with opaque porcelain, the selection of body and incisal porcelains is based largely on their esthetic properties. Body and incisal porcelains usually shrink as much as 27% to 45% of their volume during a first firing.

FABRICATION

- **PORCELAIN APPLICATION**
- **Armamentarium**

1. Porcelain modeling liquid
2. Paper napkin
3. Glass slab or palette
4. Tissues or gauze squares
5. Two cups of distilled water
6. Glass spatula
7. Serrated instrument
8. Porcelain tweezers or hemostat
9. Ceramist's sable brushes and whipping brush
10. Razor blade or modeling knife
11. Cyanoacrylate resin
12. Colored pencil or felt marker
13. Articulating tape
14. Ceramic-bound stones
15. Flexible thin diamond disk

- **Step-by-step procedure :** After the metal substructure has been oxidized, it must be inspected carefully. An uninterrupted oxide layer should cover the entire surface to be veneered.
- **Opaque Porcelain :**

1. When selecting the opaque bottle, shake it to mix the powder thoroughly. Then place it on the bench to allow the smaller pigment particles to settle. Over time, all porcelain powders will segregate into layers of different particle size if left undisturbed.
2. Dispense a small amount of powder on a glass slab or palette. Add some modeling liquid and mix it with the spatula. Metal instruments should not be used in mixing, because metal particles could rub off and act as contaminants.

3. Moisten the substructure with some of the liquid and pick up a small bead of opaque with the tip of the brush or spatula. Apply it to the coping, which should be held with the porcelain tweezers.
4. Use light vibration to spread the material thinly and evenly. Moving the serrated instrument back and forth over the handle of the tweezers will create the necessary disturbance. Excess moisture that comes to the surface can be blotted off with a clean tissue.
5. Apply a second bead on top of the first and spread it in a similar manner. To minimize the entrapment of air when the two masses meet, do not apply opaque porcelain adjacent to the initial mass.

6. Once the veneering surface is covered, add more material to a dry base. Wetting the initial application before adding more porcelain may be necessary. If not, the moisture will be absorbed immediately by the dry base layer before a new material can be properly condensed and distributed, which will result in a porous and weakened application.
7. When the entire veneering surface has been covered, remove any excess material from other surfaces with the side of a slightly moistened brush.
8. After removing any excess porcelain, carefully inspect the inside of the restoration for porcelain particles. A stiff, dry, short-bristle brush can be used to remove the particles.

9. Before firing, inspect the opaque application to see that it satisfies the following criteria :

- The entire veneering surface is evenly covered with a smooth layer that masks the color of the metal.
- There is no excess anywhere on the veneering surface.
- There is no opaque on any external surface adjacent to the veneer.
- There is no opaque on the internal aspect of the substructure.

❑ If these criteria have been met, the coping is transferred to a sagger tray and placed near the open muffle of the porcelain furnace for several minutes. This allows moisture to evaporate. When drying is completed, rinspect the work for any residual excess opaque powder. The opaque is then fired according to manufacturer recommendations.

10. After the first firing, remove the work from the muffle and set it aside to cool to room temperature.
11. At this time , inspect the opaque veneer for cracks, thin spots, and general adequacy of coverage, When the veneer is removed from the furnace, it will appear yellow; however, when it has cooled, the more representative matte-white color is apparent. **Fired porcelain should have an eggshell appearance**. Small cracks and fissures are common after the first firing. This problem can be solved by applying moisture, followed by a thin mix of opaque carefully condensed into the fissures.

12. After firing, check that the opaque application meets the following criteria :

- Relatively smooth even layer masking the color of the framework
- Eggshell appearance
- No excess on any external or internal surface of the restoration.

- **Body and Incisal Porcelains** : When a satisfactory opaque layer has been fired, the body and incisal porcelains can be applied. Bosy porcelains with increased opacity may be used where less translucency is required to mimic existing anatomic features of adjacent natural teeth. Special neck powders can be applied on the cervical third, and incisal powders on the incisal edge, to simulate natural enamel.

1. Dispense the neck, body, incisal, and other powders on a glass slab or palette. If the same slab was used for the opaque porcelain, any opaque residue must be removed.
2. Mix the powders with the recommended liquid or distilled water. The moisture content for these powders should be the same as for opaque porcelain.

8. Apply the incisal powder in the same manner and overbuild the restoration for body porcelain.
9. Mark the opposing teeth on the stone cast with a red or green felt tip marker.
10. Moisten the proximal contact areas immediately before removing the completed buildup from the cast. This reduces the risk of fracturing that portion of the buildup.
11. After the coping has been removed from the cast, fill in the proximal contact areas. At this time, the work should be reinspected for any excess material beyond the veneering area.
12. Place the restoration on a sagger tray close to the open muffle at the drying temperature recommended by the manufacturer. A drying time of 6 to 10 minutes is usually sufficient. After the drying process, once it has been determined that no undesired excess material remains, proceed with firing. When the bake is completed, the work should cool to room temperature before further handling.

13. Be especially critical when evaluating the first bake. If the surface is fissured, grind the porcelain before adding any more.
14. Remove all excess material with ceramic bound stones.
15. When the restoration has been contoured and all the necessary areas reduced, certain portions will probably require a second application of porcelain.
16. Before a second corrective bake (patch bake), clean the restoration ultrasonically to remove any grinding debris.
17. Place the second body and incisal layers directly on the slightly moistened low bisque bake. Evaluate the color at this time, keeping the restoration moist.

3. Wet the previously fired opaque layer with a small amount of the liquid and place a bead of neck powder on the cervical portion of the veneering surface. Gentle patting with a brush and light tapping on the cast will produce adequate vibration during the preliminary stage of condensation.
4. After placing the neck powder and sculpting it, build the veneer to anatomic contour with body porcelain.
5. To compensate for the firing shrinkage that results when the particles fuse, slightly overbuild the porcelain. A typical metal-ceramic anterior crown will shrink 0.6mm at the incisal edge and 0.5mm midfacially.
6. When the body buildup is completed, assess it for proper mesiodistal, faciolingual , and incisogingival contour.
7. Depending on the desired appearance, make a cut-back for the more translucent incisal powder.

INTERNAL CHARACTERIZATION

- Internal or intrinsic characterization or staining may be accomplished by incorporating colored pigments in the opaque, body, or incisal powder. These pigments are ceramic in nature and have physical properties similar to the porcelain powders.

CONTOURING

- The appearance of the finished restoration depends on its color, shape, and surface texture, which can be altered by shaping and characterizing dental porcelain to mimic the appearance of natural teeth.
- The appearance of restorations can be influenced considerably through the selected use of **optical illusion.**

GLAZING AND SURFACE CHARACTERIZATION

- Metal-ceramic restorations are glazed to create a shiny surface similar to that of natural teeth. The glazing cycle can be performed concurrently with any necessary surface characterization.
- In autoglazing the contoured bisque bake is raided to its fusion temperature and maintained for a time before cooling.
- By contrast, in overglazing, a separate mix of powder and liquid is applied to the surface of a shaped restoration, and the restoration is subsequently fired.

EXTERNAL CHARACTERIZATION

- Surface stains are highly pigmented glazes, which can be mixed with glycerin and water (supplied with most commercially available staining kits).

PORCELAIN LABIAL MARGINS

- Many patients object to the grayness at the margin associated with metal-ceramic restorations. However, hiding the margin subgingivally may not be possible. If esthetics is of prime importance, a collarless metal-ceramic crown should be considered. Collarless crowns have a facial margin of porcelain and lingual and proximal margins of metal.
- **METHODS OF FABRICATION** :

1. **Platinum Foil Matrix Technique** : The platinum foil technique uses a platinum matrix that is spot-welded to the metal substructure. Its primary purpose is to support the porcelain during firing.

2. **<u>Direct Lift (Cyanoacrylate) Technique</u>** : Because this technique is less time consuming and easier to perform than the platinum foil technique, it is more widely used. The substructure is fabricated in the same manner, but the die is coated with a layer of cyanoacrylate resin, and the porcelain is condensed directly onto it (because the die no longer absorbs moisture from the wet ceramic buildup). Seperation is achieved with a porcelain release agent.
3. <u>Porcelain Wax Technique</u> : A mixture of body porcelain and was (6:1 by weight) is applied to the die for final adaptation of the porcelain labial margin of the metal-ceramic restoration.

TROUBLESHOOTING

- **Cracks** : Surface cracks and fractures in the opaque porcelain are usually of little concern. They can be patched before the body firing begins.
- **Bubbles** : If this occurs, the porcelain must be stripped, and the procedure is started over.
- **Unsatisfactory appearance** : Careful communication, based on a thorough understanding and knowledge of relevant laboratory procedures and color science, is essential.

ALL CERAMIC SYSTEMS

- ALUMINOUS CORE CERAMICS
- SLIP CAST CERAMICS
- HOT-PRESSED CERAMICS : Leucite based, Lithium Silicate based
- MACHINED CERAMICS : Cerec system, Celay system, Procera AllCeram system
- METAL REINFORCED SYSTEMS : The Captek system, Electroformed

THANK YOU