Dental material

Sheet no. 10

Dental Ceramics

\*\* In the previous lecture we classified dental ceramics based on the particle nature into :(they differe in composition and easthetics)

1. **glassy ceramics ( pure glasses )**

Ex. Feldspathic porcelain and Hot pressed Ceramics .

1. **particle filled ceramics ( glass particle )** “ crystalline form that contain glass )

Ex. Lithium disilicate commonly known as IPsE.max .

1. **polycrystalline ( densely sintered )**

Ex. YTZP ( yttrium stabilized tetragonal polycrystals ) which commonly known as “ zirconia ceramics “

AND alumina polycrystals .

\*\* now what is available and commonly used in our practice are :

1. E.max🡪 from particle filled ceramics .
2. Zirconia 🡪 from polycrystalline
3. Feldspathic porcelain🡪 from pure glasses .

🡪we have been also talked about “ bilayered ceramics “ and “strengthening mechanism “ , which may be through adding a metal layer from below or from the prepared tooth structure such as in PFM crowns ( as we have took in the lab and we will see next year ) ,

Or through bonding with the tooth structure as we do with “ laminate veneers “ .

Or by using strong materials “ coping “ such as zirconia and lithium disilicate as core materials .

🡪currently we have what is so called “ Monolithic “ or “ monolayered “ ceramic materials , the purpose of them is to combine strength and beauty ( esthetic ) at the same time .

\*\* As we have talked in the previous lecture , when we increase the crystalline phase of the ceramics 🡪 our Crown will be more stronger , but more opaque “ which mean less esthetic “ , On the other hand , when we increase the glassy phase of the ceramics 🡪 Our Crown will be more esthetic , but will have less strength .

\*\* Nowadays , we have what so called “ ice zirconia “ which have more esthetic and enough strength .

\*\* also , lithium disilicate ceramics have a good esthetic and good strength at the same time that made them suitable to be used for construction a 3 units anterior bridge “ in the past , this was not applicable , they used the bilayered ceramics for the anterior area , however , nowadays we were able to do full contour ( monolayer ) zirconia or lithium disilicate crowns .

\*\* we also talked about the fabrication of ceramics which is done by :

1. sintering
2. casting ( ceramming )
3. pressing
4. CAD / CAM machines or copy milling machines

***Regarding Sintering :***

It means Heat , and we put the porcelain powders and this powder is added to a binder which is Water OR some Fluid similar to water added to it some molecules , this water is made as slurry ( wetted and flowy sand ) , and this slurry is manipulated by technician “ layer by layer “ , then it is put in the furnace and the temperature is adjusted according to the porcelain powder used ( High fusing porcelain , Medium fusing porcelain , Low fusing porcelain and Ultralow fusing porcelain ) .

\*\* With metal , we use the Low fusing porcelain OR the Ultralow fusing porcelain ; because we don’t want to use high temperatures that will cause the metal to melt .

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| a-High-fusing: 1288 to 1371 °C (2350  to 2500 °F)  b. Medium fusing: 1093 to 1260 °C  (2000 to 2300 °F)  c. Low fusing: 871 to 1066 °C (1600  to 1950 °F) |

\*\* Ultralow fusing porcelain is used with Titanium ; because titanium requires high casting temperatures .

\*\* feldspathic porcelain is only manufactured by Sintering .

\*\* feldspathic porcelain is considered a Veneering Ceramic , only applied on the “ outer layer “ of ceramics .

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| Ceramics- predominantly glass: Feldspathic porcelain; Veneering porcelain  e.g.: Ceramco, VM7, VM13, Vitadur  The highest aesthetic quality |

\*\* As we know , we have been divided the ceramics according to the function into :

1. Veneering ceramics
2. Core ceramics

And feldspathic porcelain ORthe pure glassy ceramics OR even lithium disilicate can be used as a veneering ceramics “ outer layer “ .

\*\* thus when we have a challenge in selection ( shade matching ) . in central incisors we focus mainly on pure glassy ceramics of feldspathic porcelain .

\*\* lithiumdisilicate is considered to have its own *“ feldspathic porcelain* “ .

\*\* before , when the porcelain was used in houses ( not in dentistry ) it was composed of Kaolin , Quartz ( silica ) and feldspar . In these porcelain the kaolin was a major component about 70% ; but in dentistry , when we used feldspathic porcelain the main component , were feldspar and Quartz , and the percentage of kaolin does not exceed 3% .

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| basic composition:  •Feldspar (potassium aluminiumsilicate)  –75-80%  •Silica  –12-22%  •Kaolin  –3-5% |

\*\* thus , the good properties of our dental porcelain are provided by Quartz ( silica ) and feldspar , which has a role in modifying the quartz ( network modification ) to the silica particles . Quartz is a very strong solid material and require very high amounts of heat to melt about 3000 C .

\*\* feldspar is compose of sodium aluminosilicate OR potassium aluminosilicate .

\*\* the dental feldspathic porcelain ( the dr. show a phase diagram ) , when we increase the temperature to 1000 C .

We are doing sintering , when we reach reach a central area ( shown in the diagram ) we will have a point between “ sintering “ and “ vitrification “.

Vitrification means that we have a crystalline matrix , as we increase the temperature we are moving into a crystalline phase . this is the last thing we want in porcelain .

Thus the porcelain furnaces that we use have a computer controlled temperature , because we don’t want the temperature to exceed a certain limit, if certain limit is exceeded ( over heating ) we will have a **crystalline deposition** which in turn will give a **dull appearance** to the feldspathic porcelain affecting the esthetic ( less esthetic ) , and this is known as ( devitrification ) .

\*\* we have talked previously that if we want to increase the crystal deposition to increase the strength we have to raise the temperature , but slowly from 6 -8 hours , in this period the crystals are rearranged in a certain pattern that will allow the light to pass through it ( translucency that we desire ) with more strength .

\*\* this was used in “ leucite based empress ceramics “ , The percentage of leucite used with the feldspathic porcelain that is used with the metal is about 20% .

As we know , if we want to increase the strength of a ceramics we add leucites .

\*\* the leucite percentage is increased from 40 – 55 % if we want to strengthen our ceramics .

\*\* In lithium disilicate the leucite particles are about 70% .

\*\* failure of ceramics Vs. failure of metal :

1. metal failure is indicated by metal deflection.
2. Ceramics failure is indicated by crack (fracture).

***\*\*\* Ceramic Repair Kit :***

in the patient mouth we should have :

1. sandblaster ( Air Abrasion ) .
2. saline coupling agent OR metal alloy primer .
3. hydrofluoric Acid itch 🡪 for the areas covered by porcelain .
4. composite .

Its not an easy job to do .

Thus , before starting our work we should know the suitable materials to use ,

1. EX. For long span bridge I should use a certain type of metal while for a short span bridge I should use another type of metal .

2. When we have high shear stress such as in “ Maryland bridges “ , we require a very stiff type of metal to prevent metal deflection .

\*\* when we have deflection , the metal will move , and the porcelain on the top may break and show metal underneath .

\*\* feldspathic porcelain is done very well as inlays , onlay , then we incorporated the leucites , and as we know the leucites are control crystalline phase that causes “ dispersion strengthening “ it increase the strength of the ceramics .

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| Shrinkage of porcelain is 21-45 %after increase the temperature  shrinkage of ceramics is more 30 - 40 % |

\*\* It was also discovered that the leucites have 2 additional features , so we have :

1. dispersion strengthening , we have a crystal phase in the middle that prevents crack propagation when it is available in 17 – 20 % with feldspathic porcelain .
2. theleucites are attacked by hydrofluoric acid itch faster than feldspathic porcelain , this will give micromechanical roughness , this micromechanical roughness give us a stronger bond strength with resin cement , that’s why one of the best ceramics for adhesive cementation are itchable ceramics , ( ie. Leucite resin forced feldspathicporcelain ) .

we have 20% of leucite that will disappear after itching ( providing the micromechanical roughness leaving uniform spaces for the resin cement and provide a strong bond .

1. the coefficient of thermal expansion of leucites is similar to the coefficient of thermal expansion of cast alloys we are using .

these features gave the leucite reinforced feldspathic porcelain to be the best type suitable for veneering of metals , Zirconia and even for lithium disilicate .

\*\* we have said that when we use the leucites in a percentage of 17 – 20% it reinforces the feldspathic porcelain by dispersion strengthening . If the percentage of leucite is increased to 45 – 55% this will provide more strength by one and a half folds than normal “ leucite reinforced feldspathic porcelain “ , this is used in “ cerraming “ technique , ( Remember , 2nd method of ceramics fabrication ) , and it uses heating in a controlled way for more than 8 hours ( EX. Pyrex ) .

\*\* In Hot Pressed ceramics , the percent of leucite is 40 – 55%.

\*\* OR we can use lithium disilicate or lithium orthophosphate m which is 3 times stronger , that’s why we are no longer using IPS empress 1 , we use IPS empress 2 or E.max ( new name for IPS Impress 2 ) .

Note : IPS empress 1 means leucite reinforced glass ceramic , while IPs empress 2 means lithium disilicate reinforced glass ceramics .

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| The crystle of Leucite is needle like structure >>the only dis advantege is the rough surface |

E.max is a new name for IPS empress 2 and it was so called because it provides strength and beauty at the same time .

\*\* ***regarding flexural strength :***

IPS empress 2 / Emax is 440 mpa Vs. 120 mpa for IPS Impress1 , “ IPS empress 2 is 3 fold more than IPS empress 1 “ .

\*\* IPs empress 1 can be used for Inlays ,Onlays , veneers and crowns , E.max also have the same uses added to it a 3 unit anterior bridge .

Note : ( posteriorly they have a high fracture rate , so they are not used ) .

\*\* the needle like structure crystals provided by the lithium in “ lithium disilicate ceramics “ , prevent the crack from propagation along the ceramic . ( As an answer to a question ) .

\*\* Itching time when lithium disilicate is used is less than the itching time when feldspathic porcelain or leucite based ceramics are used. lithium disilicate require only 10 – 20% seconds ( depending on the concentration of the itchant ) while leucite based ceramics require 60 seconds and above .

\*\* nowadays we use alumina and zirconia , but the incerame is not used anymore bcz of easthetic

\*\* In Zirconia , we use yttrium oxide partially stabilized tetragonal zirconia polycrystals .

\*\* As we know ceramics are brittle , so there are strengthening mechanisms to overcome this problem , these mechanism include :

1. lamination over the metal , over the tooth structure or over another stronger particle , such as zirconium .
2. dispersion strengthening , by leucites .(introduce a phase with different shape )
3. compression , the edge of lithium tangential disilicate are compressed , this will prevent crack propagation .( the most method used)
4. transformation toughening “ when we have crystals in more than one configuration ( more than one type of crystals )

\*\* In Zirconia , we have different crystals configurations , these include :

1. Tetragonal poly crystals 🡪 these are available in high temperatures only
2. Monoclinic crystals
3. Cubic crystals

2. & 3.🡪are available in room temperature and (different geometry =3D shape)

\*\*\* Tetragonal polycrystals have a smaller volume than monoclinic or cubic crystals and they are only available in high temperatures . To be able to stabilize these crystals at room temperature , we should add yttria 2%OR calcia OR ceria ( yttrium oxide , calcium oxide or cerium oxide ). (at room temperature is partially stabilize)

\*\* if these materials are added in a high percentage , we will have a total stabilization but we add them in small percentage .

EX. YTZP tetragonal polycrystals have 97% zirconia oxide and 2.5% mmol by volume yttrium oxide . In this case, the yttrium oxide provided partial stabilization , If we have total stabilization by adding yttrium oxide in a high percentage , this will be useless .

\*\* we desire partial stabilization ; because when we have a high pressure load that may lead to a crack , the yttrium oxide will cause a change in the crystals shape from tetragonal to monoclinic polycrystals , the monoclinic polycrystals have larger shape and they will close the crack .

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| Zirconia : the delamination (deveneering)is high which is the disadvanteges of it and has low tempreature degredation |

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| Life table analysis revealed cumulative 5-year survival rates of 95.9% for tooth-supported  and 97.1% for implant-supported crowns. For implant-supported crowns, the most  common reasons for failure were technical (veneering material fractures). For toothsupported  crowns, technical (veneering material fractures, loss of retention) and biologic  (endodontic/ periodontic) reasons for failure were equally common |

\*this is the last year sheet and the new and **extra** information from the record was adding .. Good luck!

special thanks to Khaldon for helping me .

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