Ashur university college
Lect 9&10 denture base materials

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Denture base materials

Various materials have been used to construct dentures like cellulose products, phenol- formaldehyde, vinyl resins and vulcanite, however they have suffering from a variety of problems.

Acrylic resin (polymethyl methacrylate) (PMMA) is now the material of choice to use as denture base material because it is easy to process and use, cheap and good esthetic. Even so it is not ideal in all respects.

The ideal requirements of denture base material represents by the followings:

1. Natural appearance.
2. High strength, stiffness, hardness and toughness.
3. Dimensionally stability.
4. Tasteless, odorless, non toxic and none irritating the oral tissue.
5. Insoluble in saliva or other fluids taken in to the mouth.
6. Good retention to polymer, porcelain and metals.
7. Easy to fabricate and Easy to repair.
8. Good shelf life.
9. Low density.
10. Accurate reproduction of surface details.
11. Resistance to bacterial growth.
12. Good thermal conductivity.
13. radiopacity
14. Easy to clean
15. Inexpensive to use
16. The softening temperature should be higher than mouth temperature.

Types of acrylic resins

1. **Heat cured resin.**
2. **Cold cured resin.**
3. **Visible light cured resin.**
4. **Microwave activated resin.**

Classification of denture base materials:

According to the Type of Materials

- **metallic e.g. Cr/Co denture base**
- **nonmetallic materials e.g. poly (methyl methacrylate)**

According to the Method of Polymerization

- **Addition polymers, e.g. poly (methyl methacrylate)**
- **Condensation polymers, e.g. nylon.**

According to their Thermal Response

- **Thermoplastic, e.g. polyvinyl acrylics and polystyrene.**
- **Thermosetting, e.g. poly (methyl methacrylate).**

Classification of denture base materials:

According to the Method of Activation

- ***Thermal***; **e.g. poly (methyl methacrylate).**
- ***Microwave*; e.g. poly (methyl methacrylate).**
- ***Catalyst*; e.g. poly (methyl methacrylate).**

***Visible light activated*; e.g. Urethane di methacrylate**

According to the Dispensing System

- **Power and liquid system, e.g. heat-cure and self-cure acrylic resins.**
- **Sheets and ropes: (Single component system), e.g. light activated denture base resins.**
- **Gel type, e.g. vinyl acrylics.**

Heat cure denture base resin:

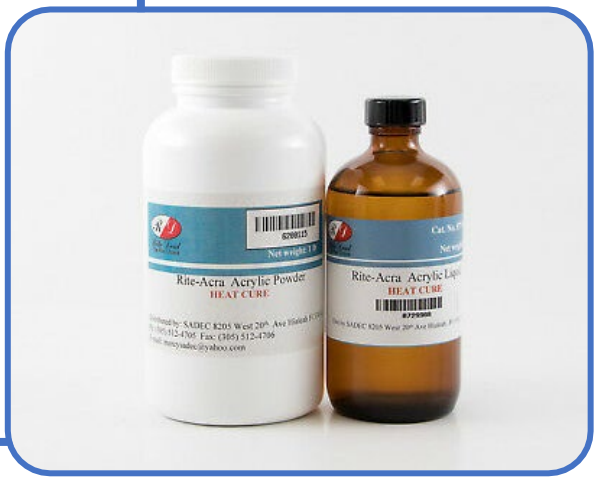
Compositions: The heat cure acrylic resin supplied as powder and liquid.

Powder:

1. **Poly methyl methacrylate beads or granules.**
2. **Benzoyl peroxide (initiator to produce free radicals).**
3. **Dibutyl phthalate (Plasticizer to make it softer and added flexibility).**
4. **Zinc or titanium oxide (opacifier to make it radio-opaque).**
5. **Pigments.**
6. **Synthetic fibers (nylon acrylic to look like blood vessels and to give the gingival tissues natural appearance).**

Liquid:

1. **Methyl methacrylate monomer.**
2. **Cross linking agent that improves the mechanical properties**
3. **Hydroquinone Inhibitor prevent setting while storage.**



Heat cure denture base resin:

Properties of Methyl methacrylate monomer

- **It is a clear transparent liquid (colorless), liquid at room temperature. It has typical smell of its own.**
- **Can get evaporated (Volatile).**
- **Inflammable.**
- **Should store in dark colored bottle.**
- **It is a known allergen.**
- **Boiling point 100.8 C.**
- **Light weight.**
- **Volumetric shrinkage during polymerization of 21%.**



Manipulation of heat cure acrylic resin (Polymer-monomer interaction):

The liquid is placed in clean and dry mixing jar then powder is added slowly and mixed in proper proportion (Powder /liquid ratio is 3:1 by volume or 2.5:1 by weight) and allow each powder particles to become wetted by monomer and workable mass is formed and left until it reaches a consistency suitable for packing. During this period, a cover should be placed above the mixing jar to avoid monomer evaporation. The type of the reaction is addition polymerization reaction (it is extremely exothermic reaction).

Manipulation of heat cure acrylic resin (Polymer-monomer interaction):

The resultant mixture will pass into 5 stages:

1. **Sandy stage: the monomer wets the outside of the polymer's particles.**
2. **Sticky stage: the monomer attaches the surface of the polymer beads, some polymer chains are dispersed in the liquid monomer, the viscosity of the mixture is increased, this stage is characterized by stickiness when the materials is touched.**
3. **Dough like stage: when the monomer diffuses further into the polymer particles and the mass become saturated. The mass does not adhere to the walls of the mixing jar; clinically the mass behaves like as pliable dough.**
4. **Rubber or elastic stage: in this stage monomer is dissipated by evaporation and by further penetration into the remaining polymer beads. The mass can not be molded, its rubber like.**
5. **Stiff stage: the mixture becomes stiff, this may be attributed to the evaporation of free monomer. Clinically the mixture appears very dry.**

Manipulation of heat cure acrylic resin (Polymer-monomer interaction):

Dough forming time: the time from beginning of mixing of polymer with monomer until reaching the dough like consistency less than 10 min.

Working time: The time that the mixture remains in dough like stage. The dough remains moldable for at least 5 mins. the working time is affected by temperature. In warm weather when the working time is insufficient can be extended by refrigeration (the resin store in refrigerator in air tight container to avoid moisture contamination).

The complete Polymerization not occurs until the denture flask is heated to above 70C. (In heat activated acrylic resin)

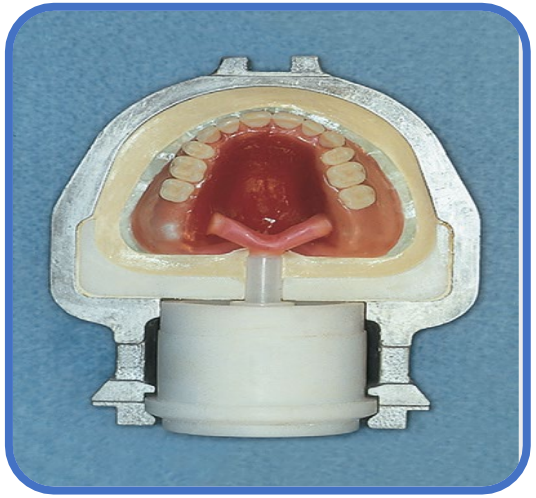
The chemically activated materials start to polymerization soon after the powder and liquid are mixed and proceed more rapidly through the various consistency stages than the heat accelerated types.

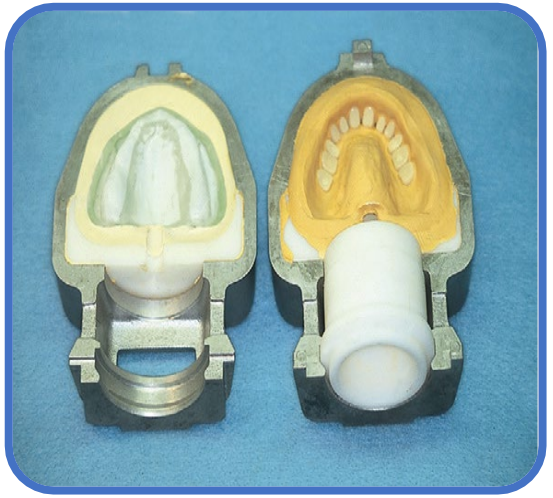
Technical consideration:

Heat activated denture resin are shaped by:

1. **Injection molding technique.**
2. **Compression mold technique.**

<u>Injection molding technique:</u> This technique required a special thermoplastic resin and special equipment. The fluid resin is contained in the injector and is forced into the mold space as needed. It is kept under pressure until it has hardened.






Compression mold technique:

2. Compression mold technique: This is the most commonly used technique in the fabrication of acrylic resin denture. The steps of this technique are:

- Preparation of the waxed denture pattern.
- Preparation of the mold. (Flasking, De waxing).
- Application of separating medium.
- Mixing of powder and liquid (Placing acrylic dough in the mold).
- Packing, closing the flask together and removing the excess.
- Curing (Heat curing under pressure, the denture flask under pressure is placed in heated water bath or microwave oven).
- Cooling. Deflasking, finishing and polishing.









Polymerization cycle or curing cycle: it is the technical name for the heating process used to control the initial propagation of polymerization in the denture mold.. Curing may be done either:

1. In water bath to raise the temperature.
2. In microwave oven (where the flask used should be non-metallic type).

There are two recommended curing cycles:

1. Long curing cycle: Curing in a constant temperature water bath (8hr-10hr at 74 ^{0}C). (The satisfactory processing).
2. Short curing cycles: curing for 1.5- 2hr at 74 ^{0}C then 1hr at 100 ^{0}C.

Chemically activated resin (auto polymerized or cold cure or self-cure polymethyl methacrylate):

Composition same as the heat cure version with following differences

1) **The powder contains small particles size beads of polymer of poly methyl methacrylate that have a lower molecular wt. and contain benzyl peroxide (initiator).**
2) **The liquid contains a chemical activator ((1-2%) tertiary aromatic amine) which activated the benzyl peroxide (initiator) to produce free radicals so that polymerization is initiated in manner similar to that describe for heat cure acrylic. (Upon mixing tertiary amine causes activation of benzyl peroxide).**



Compared to heat cure acrylic:

1. Low molecular weight (degree of polymerization not completed compared to that achieved using heat activated). Dentures processed have more residual monomer (3-5%). While heat cured resin is reach up to 1%.
2. Color stability inferior (tertiary aromatic amine susceptible to oxidation), stabilizing agents should be added.
3. Working time is shorter than heat cure acrylic. The chemically accelerated materials start to polymerize soon after the powder and liquid are mixed and proceed more rapidly through the various consistency stage than the heat accelerated type.
4. Less shrinkage than heat cures resin (Lower dimensional change).
5. Decreased transverse strength (residual monomer act as plasticizer).
6. Lower hardness.



Light activated denture base resins:

This material is a composite having a matrix of urethane dimethacrylate with an acrylic copolymer, microfine silica fillers, inhibitors and light initiator for polymerization (comphorquinone amine).

It is supplied in premixed sheets (Single component) and rope form in light proof pouches having clay like consistency. It is polymerized in a light chamber (curing unit) with visible blue light (400-500nm) is the activator in curing unit.







Heat cured acrylic

(Activator)

Polymer + Peroxide initiator (Powder) + Monomer + Inhibitor (Liquid) + Heat (external) ⟶ Polymer + Heat (reaction)

Cold cured acrylic

Polymer + Peroxide initiator (Powder) + Monomer + Inhibitor + Amine accelerator (Liquid) ⟶ Polymer + Heat (reaction)

Microwave polymerized polymer:

Resins are the same as used with conventional material or using specially microwave acrylic resin and are processed in a microwave by using non-metallic flask. The properties and the accuracy of these materials have been shown to be as good as or better than those of the conventional heat cured material. The advantages of microwave curing are cleaner and faster than the water bath polymerization. Processing time is much shorter (4-5 min).





Thermoplastic polymer (flexible dentures):

Thermoplastic resins are used for the fabrication of flexible denture. A thermoplastic is a plastic which becomes pliable or moldable above a specific temperature and returns to a solid state upon cooling. There are different kinds of thermoplastic resin like:

1. **Thermoplastic acetal.**
2. **Thermoplastic acrylic.**
3. **Thermoplastic polycarbonate.**
4. **Thermoplastic nylon.**



Processing Errors:

1. **Porosity:** **Presence of voids or bubbles within structure of resin. When the porosity present in the surface it:**

- **Makes the appearance of the denture base unsightly.**
- **Proper cleaning of the denture is not possible, so denture hygiene and oral hygiene is suffered.**
- **It weakens the denture base.**

Porosity can be of two types: internal porosity and external porosity.



Internal denture porosity:

it is in form of voids and bubbles within the mass of polymerized acrylic. Not present on the surface of the denture. It is developed in thick portion of the denture base. Causes:

1. **Vaporization of the monomer when the temperature of the resin increases above the boiling point of the monomer (100.8 ^{0}C).**
2. **Very low molecular weight polymer exothermic heat of the surface resin dissipates easily into the investing plaster.**
3. **The center of the thick portion, the heat cannot be conducted away therefore the temperature in the thick portion may rise above the boiling point of monomer causing porosity.**

Minimized by: Denture with excessive thickness should be cured using long and low temperature curing cycle.

External denture porosity:

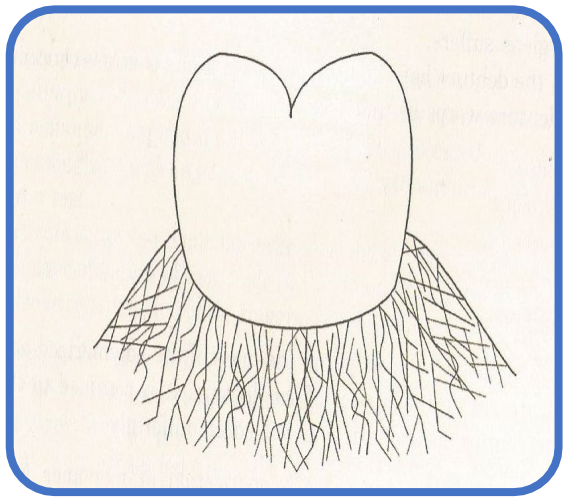
it can occur due to two reasons

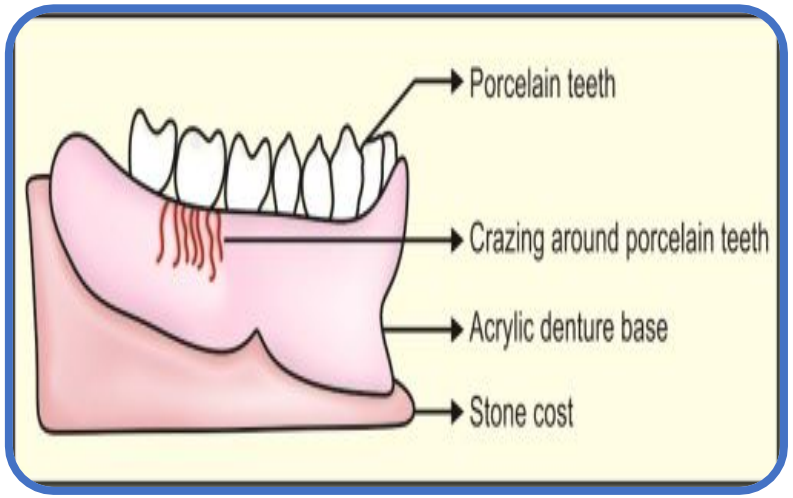
1. **Lack of homogeneity: Causes: if the dough is not homogenous at the time of polymerization, the portions containing more monomer will shrink more than the adjacent area. This localized shrinkage results in voids, the resin appears white. Minimized to by Using proper powder liquid ratio and mix it well. The mixture is more homogenous in the dough stage (so packing should be done in dough stage).**
2. **Lack of adequate pressure: Causes: lack of pressure during polymerization or inadequate amount of dough in the mould during final closure cause bubbled which are not spherical and the resin color is lighter. Minimized by using the required amount of dough in flask and check for excess of flash during closure (flash indicated adequate material).**

2. Crazing:

Crazing is formation of surface cracks on denture base resin and has a weakling effect on the resin and reduces the esthetic qualities. The cracks formed can cause fracture. Causes:

- **Mechanical stresses (tensile stress).**
- **Attack by solvent (alcohol)**
- **Incorporation of water during processing.**

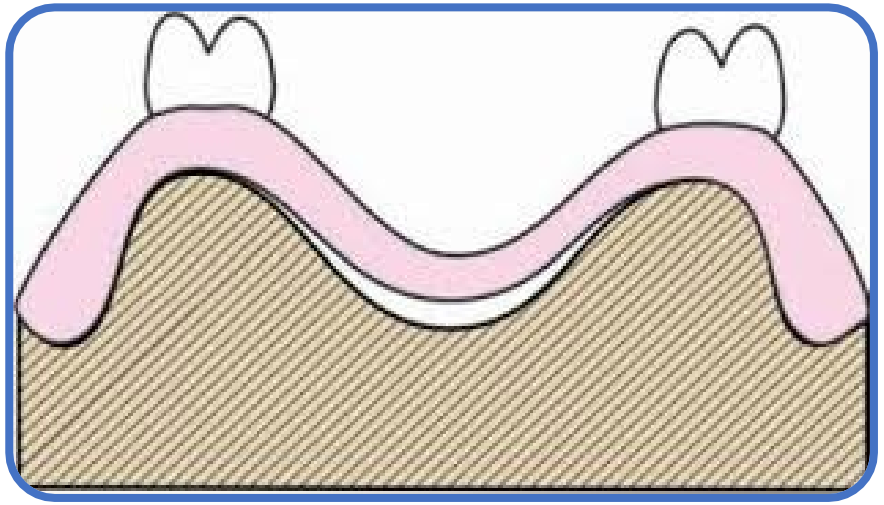




3. Denture warpage:

it is change in shape or deformation of denture which can affect the fit of the denture. Warpage can occur during processing as well as at other times. **Cause** by

- Release of stresses incorporation in denture during processing. Causes of stress are (curing shrinkage or rapid cooling or packing of the acrylic in rubber stage or improper deflasking).
- Rise in temperature while polishing.
- Immersion of processed denture in hot water.
- Re curing of the denture after addition of relining material.
- Repeated wetting and drying cause warpage of the denture.





Thank you