Non Metallic Denture Base Materials

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Introduction

- The denture base is that part of the denture that rests on the soft tissues and holds the artificial teeth.
- Many polymeric materials were used for denture base construction.
- Nowadays, acrylic resin is the mostly used material universally.

Ideal requirements of denture base material

1. It should be insoluble and non-absorbent in the oral cavity.

2. It should be non-toxic and non-irritant.

Ideal requirements of denture base material

3. It should have **good physical properties**:
   a) The coefficient of thermal expansion and contraction of denture base and artificial teeth should be the same to avoid crazing.
   b) The density should be low to help in upper denture retention.
   c) The thermal conductivity should be high to give physiologic stimulation to underlying tissues.
   d) The esthetics should be satisfactory and should simulate natural appearance.

Ideal requirements of denture base material

4. It should have sufficient mechanical properties.
5. It should be dimensionally stable during construction and during patient use.

Ideal requirements of denture base material

6. It should provide good retention with artificial teeth.

7. It should be inexpensive and easily constructed.

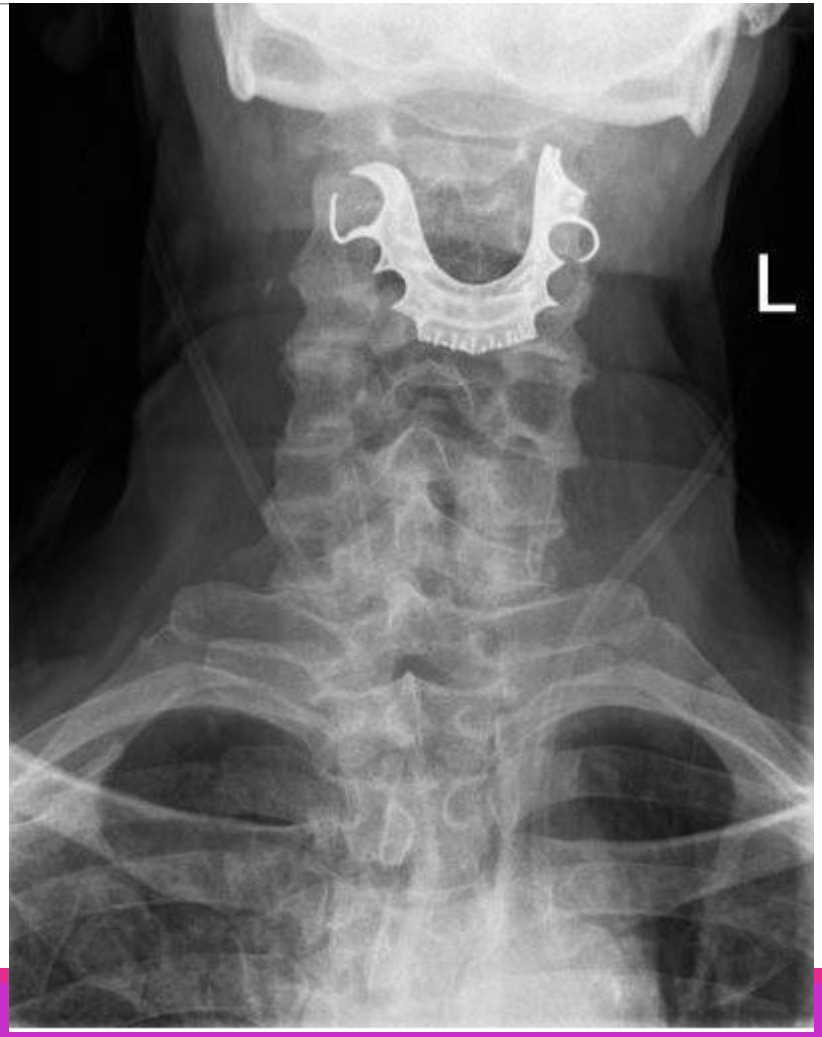
Ideal requirements of denture base material

8. It should accept teeth addition and repaired easily.

9. It should be easily cleaned by the patient.

Ideal requirements of denture base material

10. It should be radio-opaque for easily detected by radiograph if accidentally inhaled or ingested.



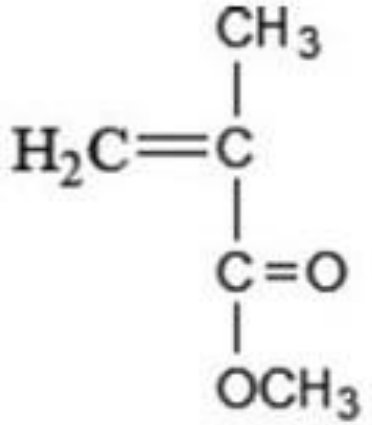
Acrylic resin denture base material

Acrylic Resin

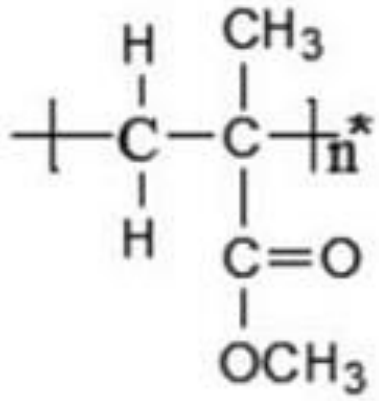
- It is widely used for fabrication of denture bases, special trays, denture liners, provisional restorations and maxilla-facial prosthesis.

Acrylic Resin

- It is poly-methyl methacrylate polymer that is polymerized by an addition polymerization reaction.



MMA Monomer



PMMA Polymer

Acrylic Resin

- It is activated either by heat or chemical reaction.
- Pure poly-methyl methacrylate is transparent and it is pigmented with different colors to obtain tissue-like shades.

Heat cured acrylic resin

Mode of supply:

- Powder and liquid

Heat cured acrylic resin

Composition:

- Powder:
  1. Beads or granules of poly-methyl methacrylate (pre-polymerized PMMA).
  2. Initiator (benzoyl peroxide): To initiate the polymerization reaction of liquid after mixing to powder and liquid.
  3. Pigments: To give tissue-like shades.

Heat cured acrylic resin

Composition:

- Powder:

4. Radio-opacifiers: To give radio-opacity.
5. Fibers (acrylic or nylon): to simulate blood vessels appearance.
6. Plasticizers: to give resiliency and soft polymers.

Heat cured acrylic resin

Composition:

- Liquid:
  1. Monomer: methyl methacrylate (MMA).
  2. Inhibitor (hydroquinone): To inhibit pre mature polymerization reaction during accidental exposure to heat or light during storage.
  3. Cross-linking agent (glycol dimethacrylate): To improve mechanical properties.

Heat cured acrylic resin

Setting reaction:

- Free radical addition polymerization reaction.
- It is accompanied by:
  1. Polymerization shrinkage
  2. Evolution of heat
  3. Residual monomers

Heat cured acrylic resin

Manipulation and Processing:

- Heat cured acrylic resin is packed inside a mold.

Heat cured acrylic resin

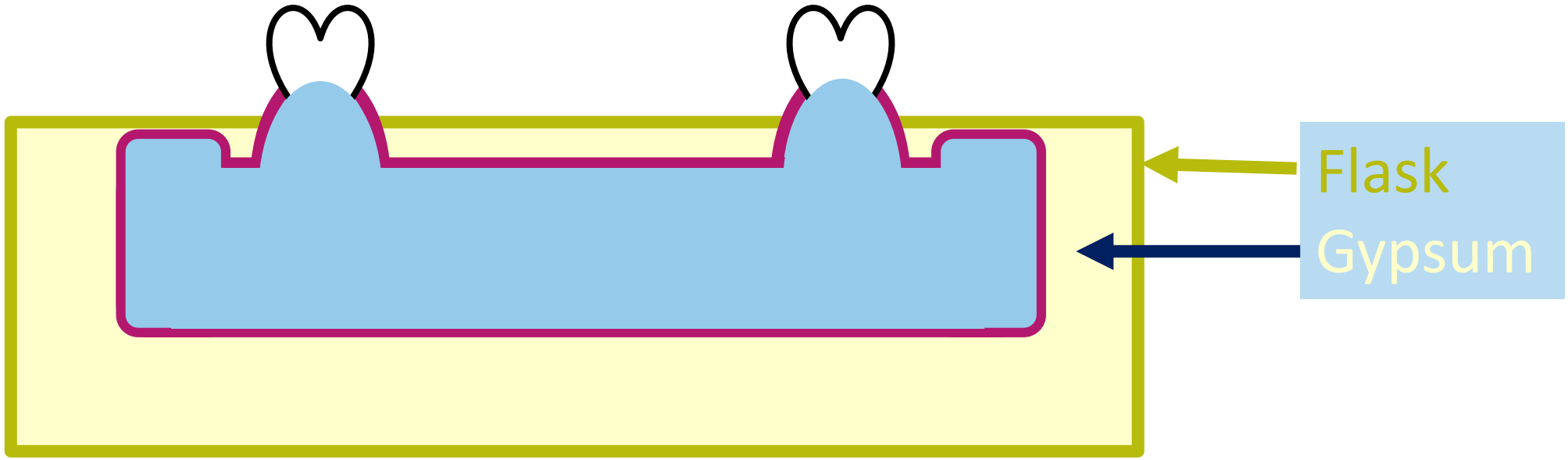
Manipulation and Processing:

- **Steps of Mold formation:**
- The waxed up trail denture base with set teeth are sealed over master cast.

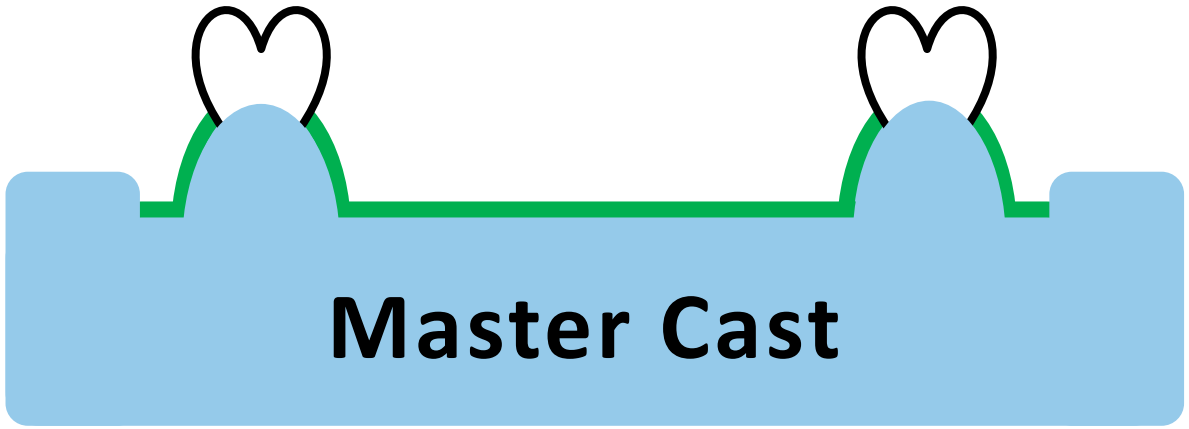
Heat cured acrylic resin

Flask

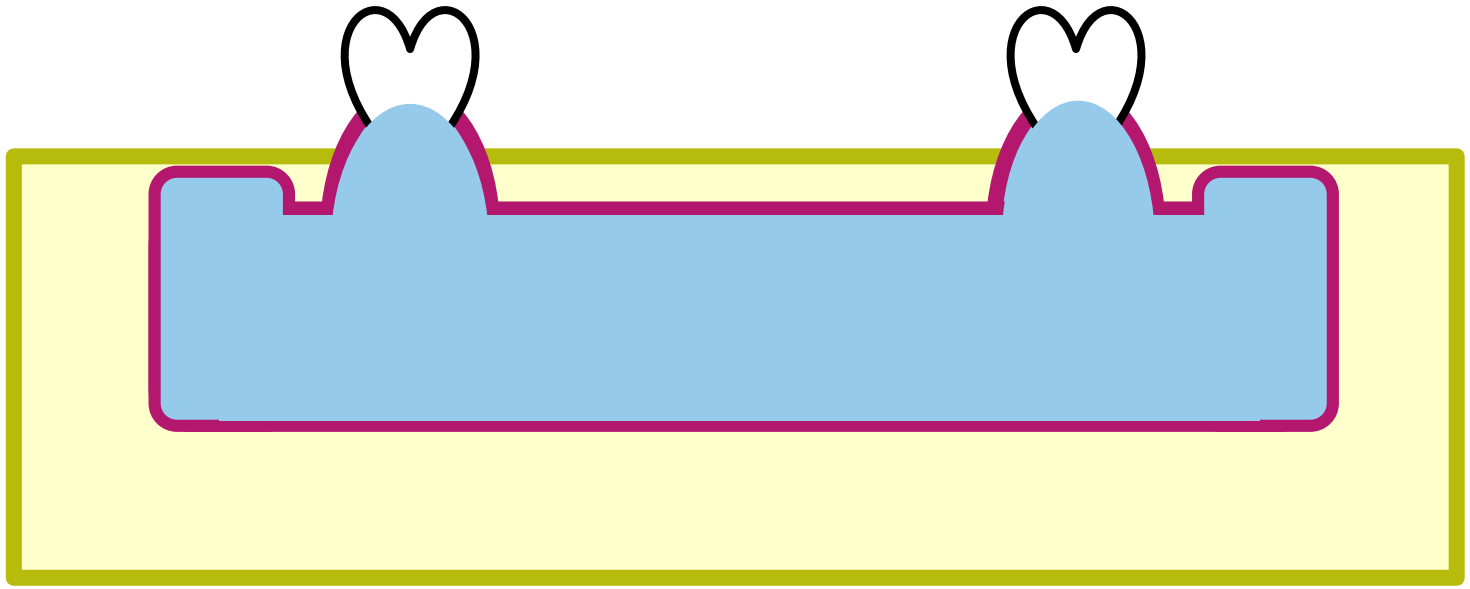
The lower part of the flask is filled with freshly mixed gypsum (dental stone) then the master cast with trail denture base and set teeth are partially immersed into gypsum.



The master cast is painted with separating medium for easily separation of the master cast from gypsum

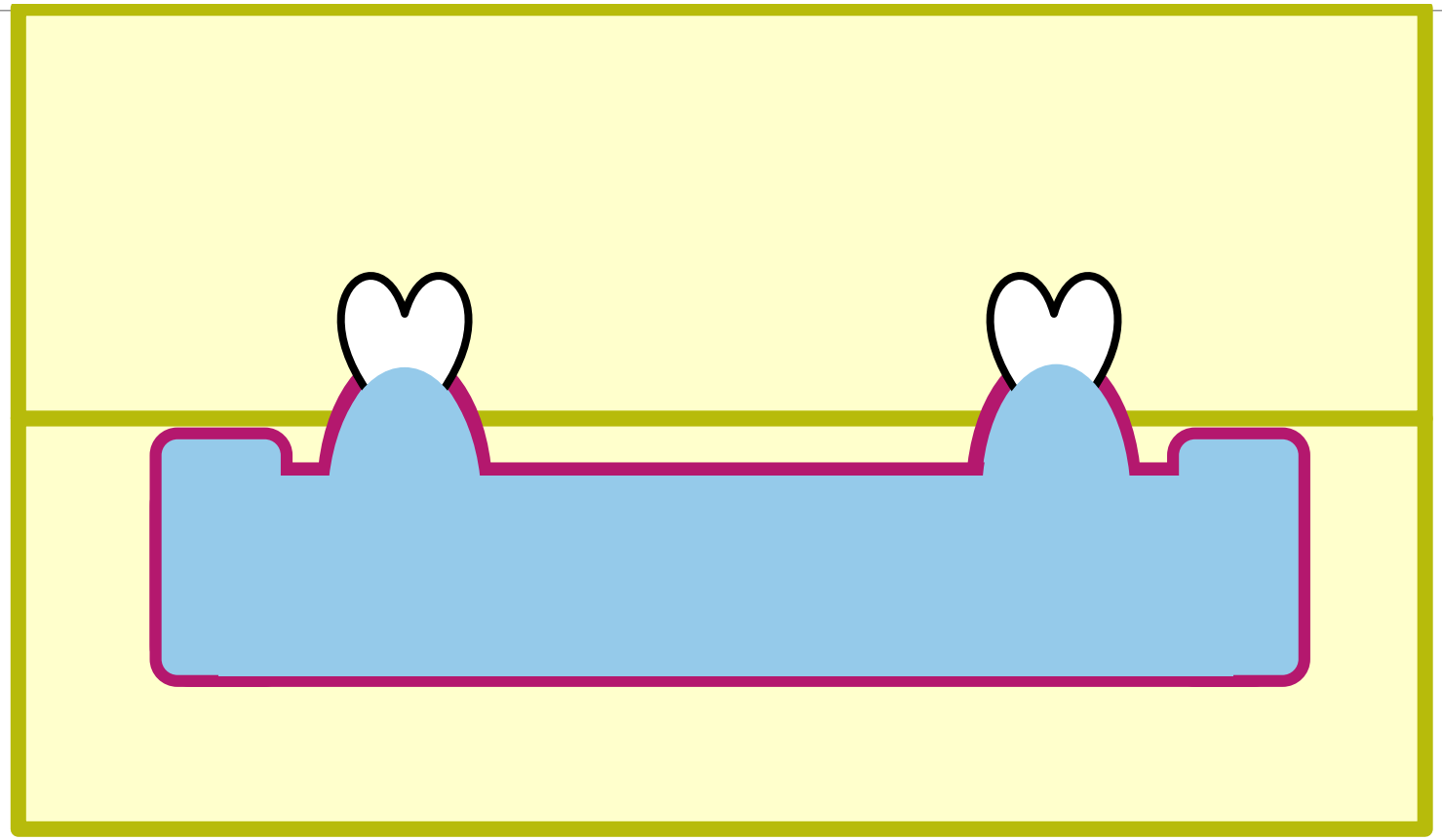


After initial set of the gypsum, it is painted with a separating medium for easily separation of the upper and lower parts of the flask.

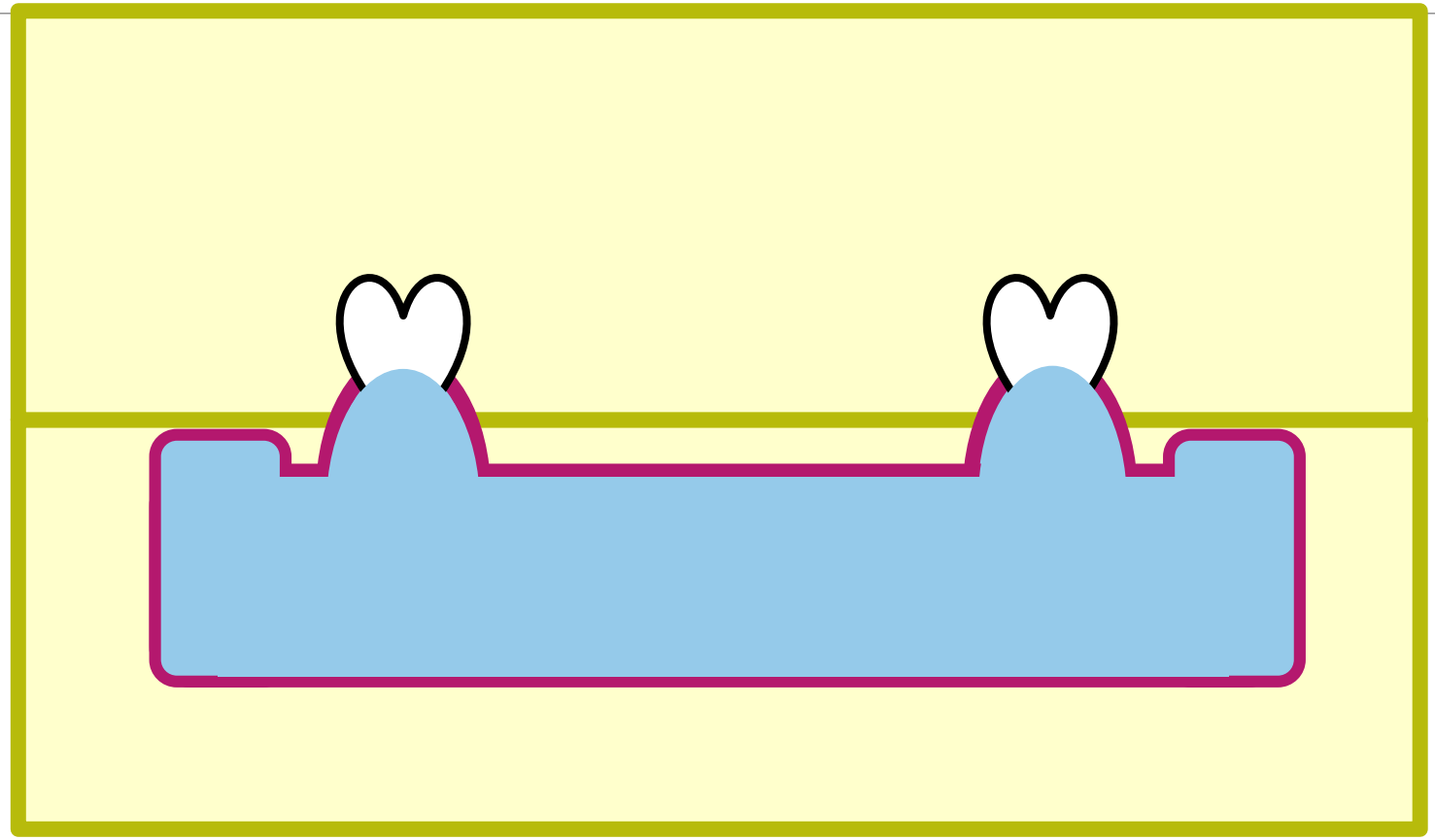


Do not cover the **occlusal surface** of the teeth so they attached with the freshly mixed gypsum of the upper part of the flask.

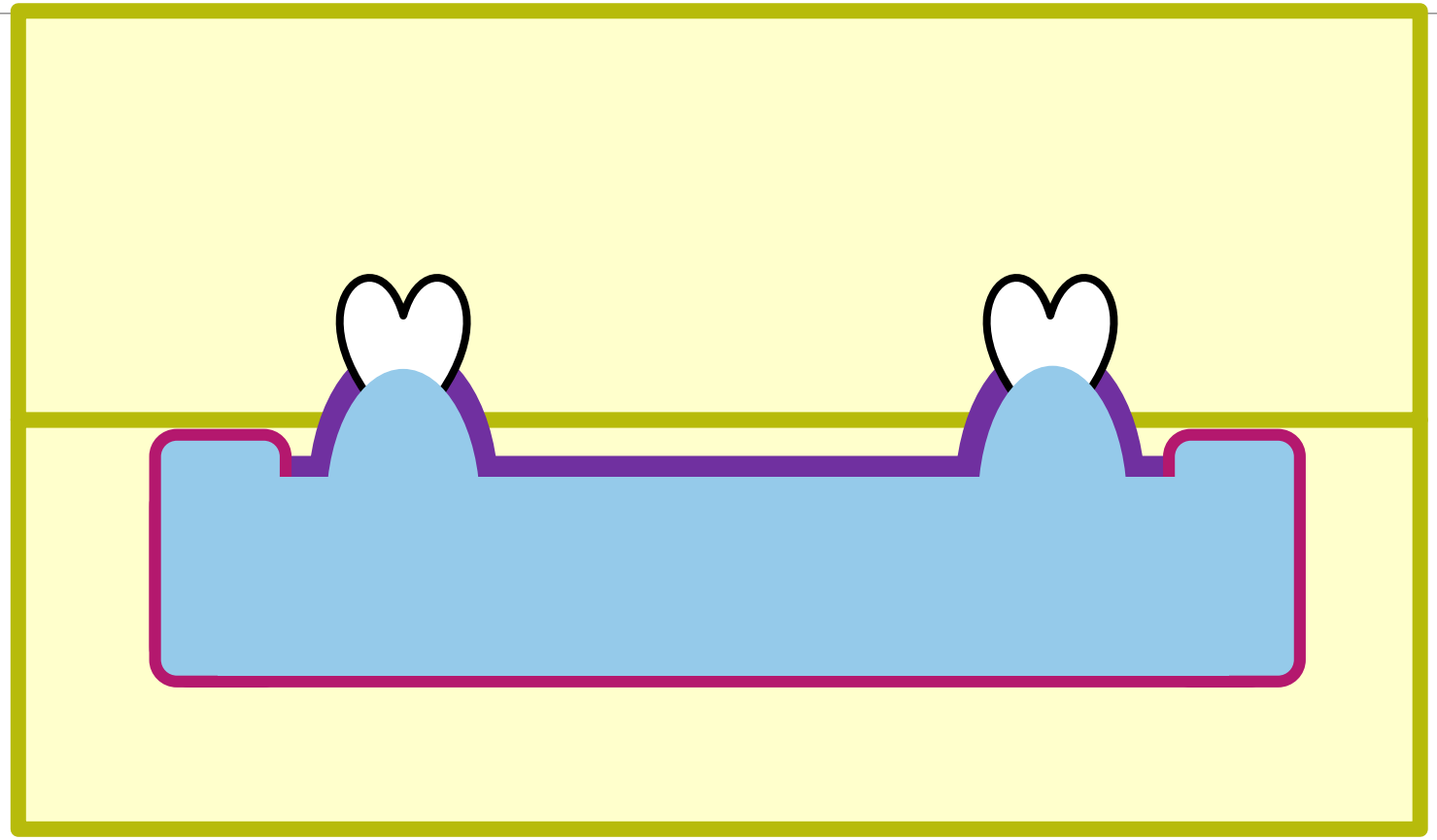
The upper part of the flask is placed over the lower part and filled with another fresh mix of gypsum.

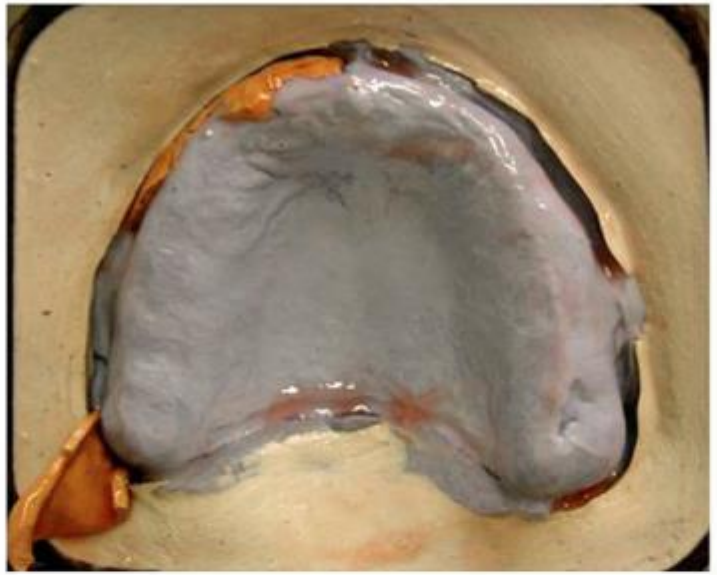


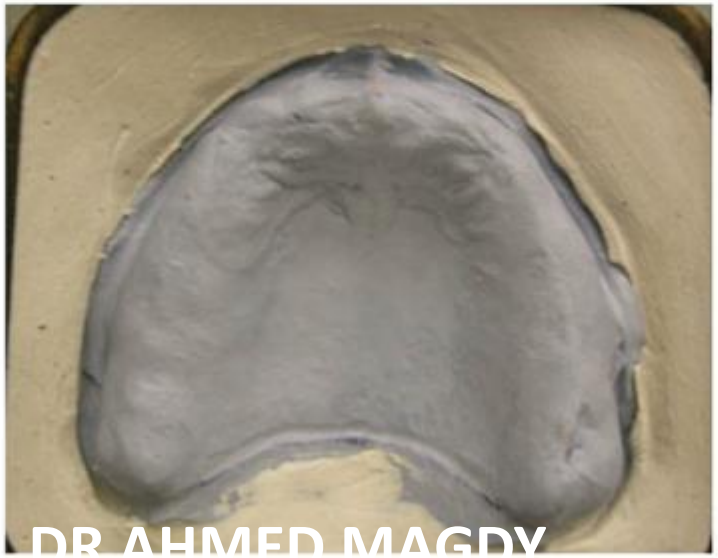
After setting of the gypsum, the flask is placed inside boiling water to soften the wax.



Remove the trail denture base and any wax remnants.

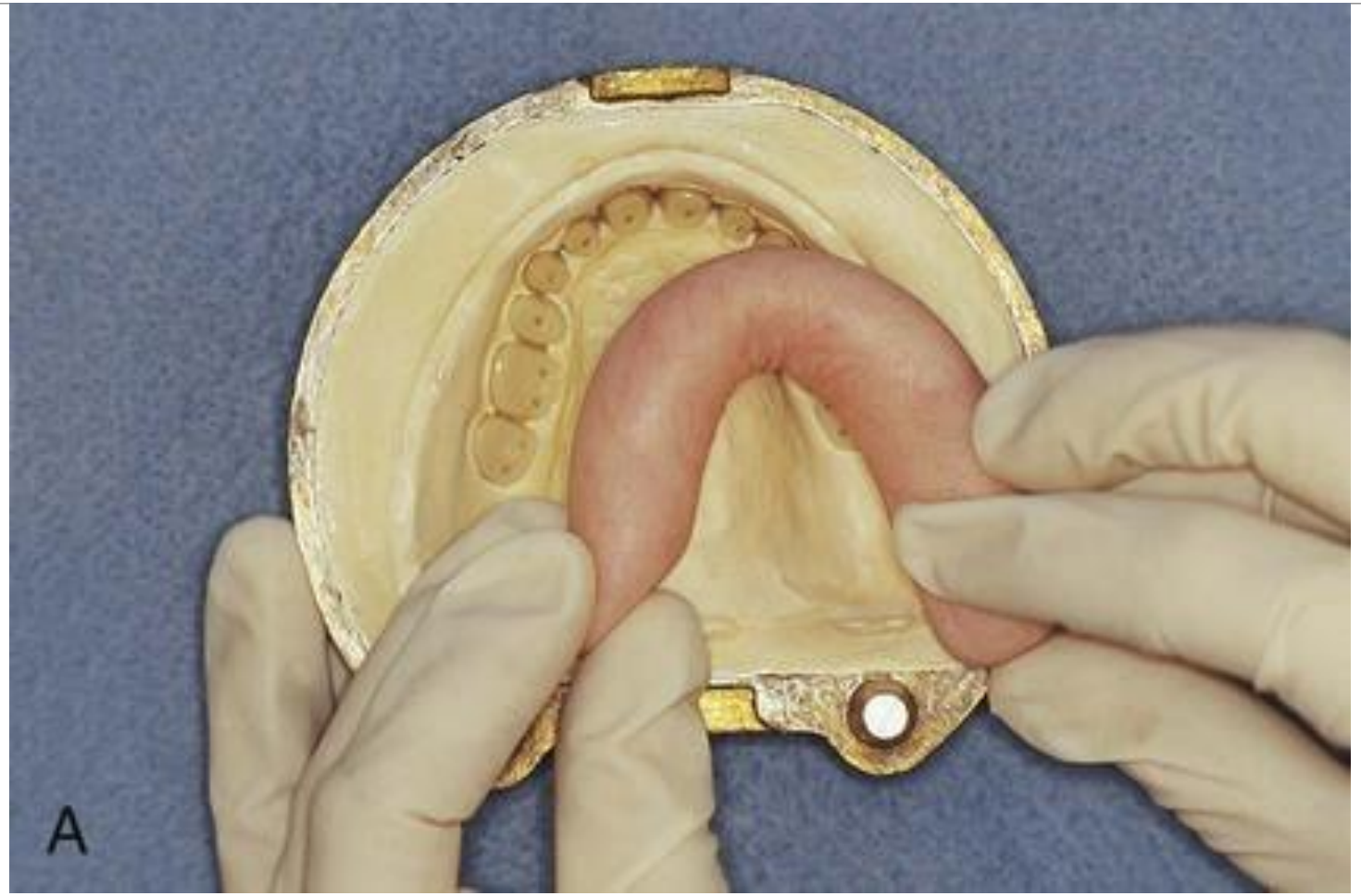




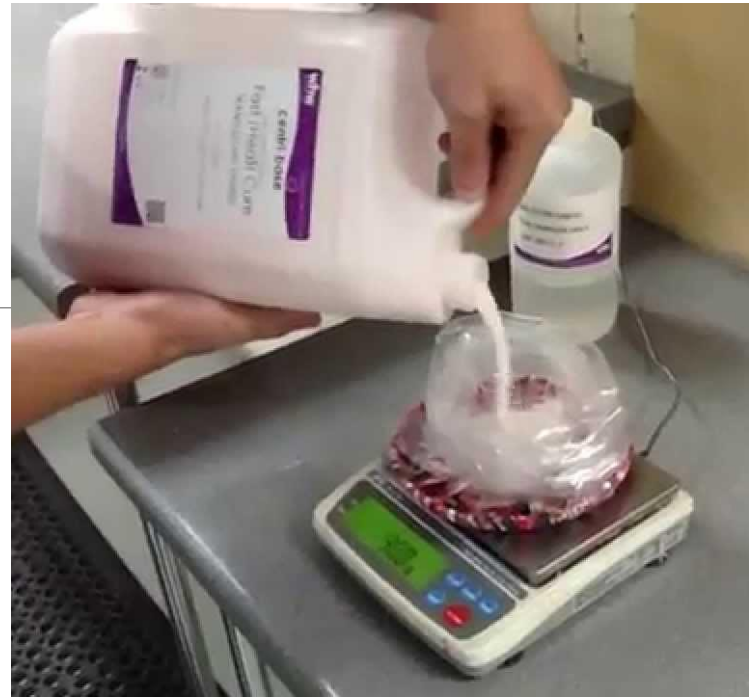


Paint the inner surface of the mold with separating medium except the **fitting surface of the teeth**.

Now the mold is ready for packing of the heat cured acrylic resin.



Heat cured acrylic resin



Manipulation and Processing:

1. **Proportioning of powder and liquid:**

- P/L is 3:1 by volume or 2.5:1 by weight.
- High P/L ➔ will cause incomplete wetting of the powder with liquid leading to granular mix.
- Low P/L ➔ will lead to increase shrinkage and porosity of the denture.

Heat cured acrylic resin

Manipulation and Processing:

2. **Mixing:**

- Mixing is done by a stainless steel spatula inside a glass jar.

Heat cured acrylic resin

Manipulation and Processing:

2. **Mixing:**

- The mix pass through the following physical stages:
  1. Sandy stage.
  2. Sticky (stringy) stage.
  3. Dough stage.
  4. Rubbery stage.
  5. Stiff stage.

Heat cured acrylic resin

Manipulation and Processing:



Heat cured acrylic resin

Manipulation and Processing:

Heat cured acrylic resin

Manipulation and Processing:

2. **Mixing:**

- The mix is packed inside the mold at the dough stage.
- Until reaching the dough stage, the mix is left inside a sealed jar to avoid evaporation of the monomer.

Heat cured acrylic resin

Manipulation and Processing:

3. **Separating medium application (sodium alginate):**

- Before packing, the inner surface of the mold (except the fitting surface of the teeth) should be painted with a separating medium.

Heat cured acrylic resin

Manipulation and Processing:

3. **Separating medium application (sodium alginate):**

- Role of separating medium:
  1. Prevent passage of water from gypsum to resin to avoid resin crazing.
  2. Prevent passage of monomer from resin to gypsum to prevent porosity.
  3. Decrease surface porosity.
  4. Facilitate separation of the two parts of the flask.

Heat cured acrylic resin

Manipulation and Processing:

3. **Separating medium application (sodium alginate):**

Heat cured acrylic resin

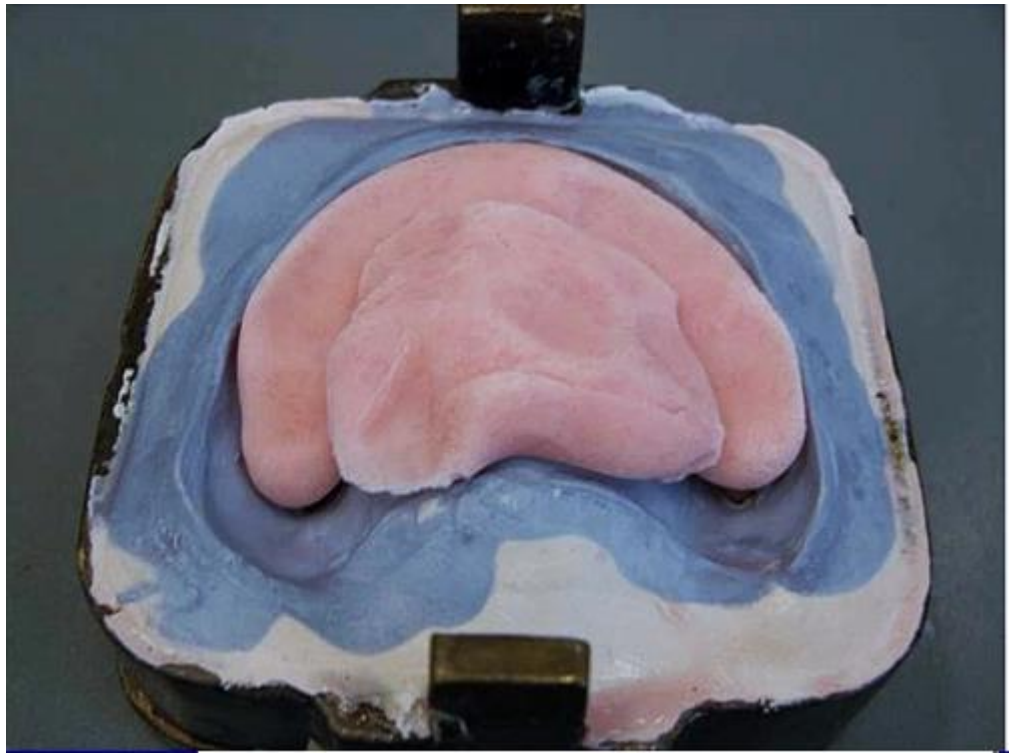
Manipulation and Processing:

4. **Packing:**

- Packing is done at the dough stage.
- The mold should be overfilled with acrylic resin and sufficient pressure is applied on the flask to compensate polymerization shrinkage of the acrylic resin.

Heat cured acrylic resin

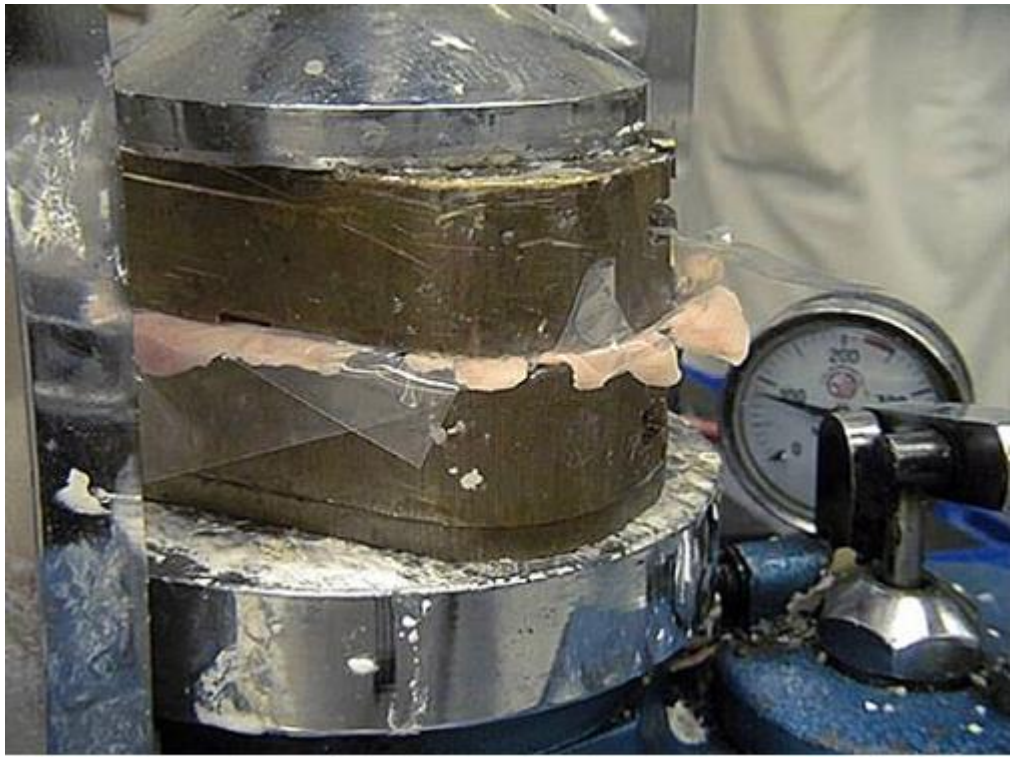
Manipulation and Processing:



Heat cured acrylic resin

Manipulation and Processing:

4. **Packing:**



Heat cured acrylic resin

Manipulation and Processing:

4. **Packing:**

- Early packing at sandy or sticky stages leads to:
  a) Flow of the mix outside the flask due to their lower viscosity.
  b) Denture porosity as a result of monomer evaporation.

Heat cured acrylic resin

Manipulation and Processing:

4. **Packing:**

- Delayed packing at rubbery stage leads to:
  a) The two parts of the flask will not contact due to high viscosity of the mix.
  b) Movement or fracture of the artificial teeth.

Heat cured acrylic resin

Manipulation and Processing:

5. **Processing:**

- To cure acrylic resin and reach the stiff stage, heat is applied in a water path.
- The time and temperature of heat application should be controlled.

Heat cured acrylic resin

Manipulation and Processing:

5. **Processing:**

- Decrease curing time (under curing) leads to high residual monomers.

Heat cured acrylic resin

Manipulation and Processing:

5. **Processing:**

- Increase curing temperature (over curing) will lead to increase the temperature inside the mold.
- This will lead to boiling and evaporation of monomer (at 100.3 °C) before its polymerization and result in gaseous porosity.

Heat cured acrylic resin

Manipulation and Processing:

5. **Processing:**

- The heat accumulated inside the mold arises from
  - Applied heat
  - Heat of polymerization reaction (exothermic reaction).
- This accumulated heat will not dissipate easily due to lower thermal conductivity of the gypsum.

Heat cured acrylic resin

Manipulation and Processing:

5. **Processing:**

- Curing cycles:
  a) Long cycle:
     - Constant temperature is applied at 74°C for 8 hours.
  b) Short cycle:
     - Heat is applied at 74°C for 2 hours then increase the temperature until water boiling (100°C) for addition 1 hour.

Heat cured acrylic resin

Manipulation and Processing:

6. **Deflasking and finishing:**

- After completion of curing cycle, the flask is removed from the water bath and allowed to be cooled to room temperature then opened.
- Opening of the flask before cooling leads to denture warpage.

Heat cured acrylic resin

Manipulation and Processing:

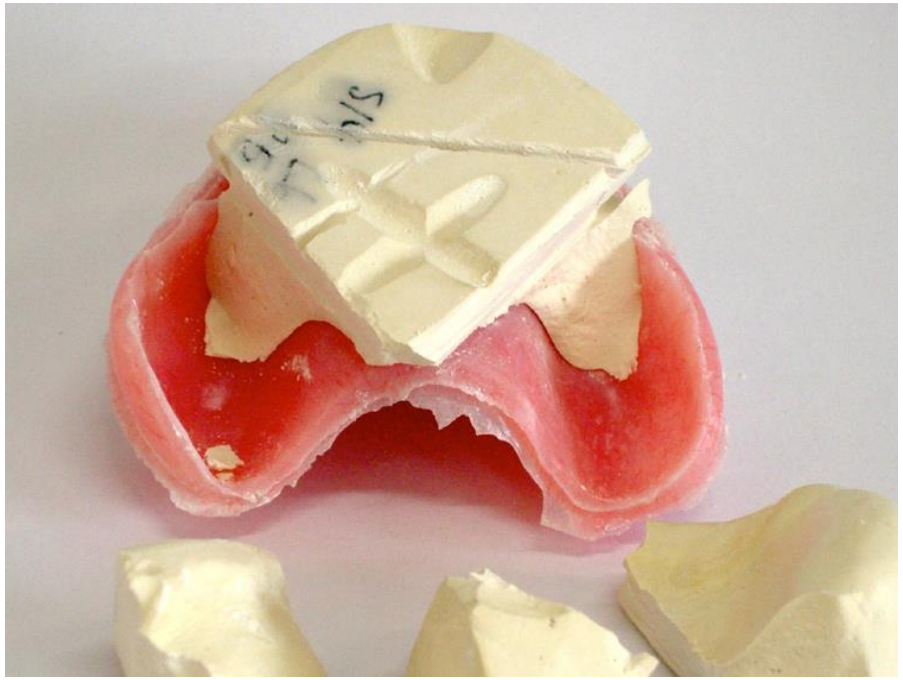
6. **Deflasking and finishing:**

- Rapid cooling of the flask leads to generation of internal thermal stresses.
- After cooling, the denture is removed from the flask and cleaned from the gypsum debris then finished and polished.

Heat cured acrylic resin

Manipulation and Processing:

6. **Deflasking and finishing:**



Heat cured acrylic resin

Manipulation and Processing:

6. **Deflasking and finishing:**

- Denture should be stored in water until delivery.

Chemical cured acrylic resin

- Cold Cured Acrylic Resin
- Self Cured Acrylic Resin
- Chemical Cured Acrylic Resin

Chemical cured acrylic resin

Mode of Supply:

- Powder + liquid

Chemical cured acrylic resin

Chemical composition:

- Like heat cured acrylic resin + chemical activator (N, N dihydroxyethyl para toluidine) added to the liquid.

Properties of acrylic resin

1. **Shrinkage:**

a) Polymerization shrinkage

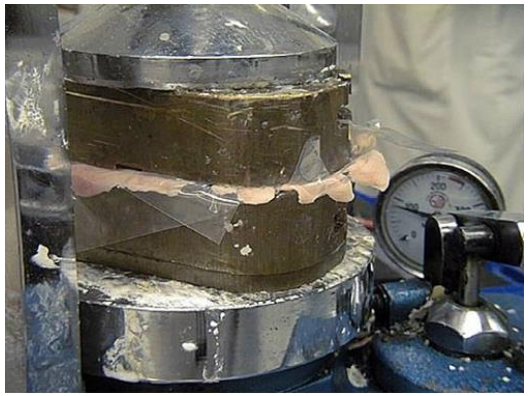
- The polymerization shrinkage of methyl methacrylate (pure monomer) is 21%.
- In denture construction, pre-polymerized powder is mixed with monomers with a ratio of 3:1 by volume.
- This leads to polymerization shrinkage of about 6%.

Properties of acrylic resin

1. **Shrinkage:**

a) Polymerization shrinkage

- As the powder is polymer so it will not shrink and the monomer only will shrink upon polymerization.
- The mold is overfilled to minimize the amount of polymerization shrinkage.



Properties of acrylic resin

1. **Shrinkage:**

b) Thermal shrinkage

- It occurs due to cooling of the denture from processing temperature to the room temperature.
- This leads to shrinkage about 0.44%.
- This shrinkage is compensated by water sorption.

Properties of acrylic resin

2. **Residual monomers:**

- The properly heat cured acrylic resin produce 0.2:0.5 % residual monomer.
- The under cured dentures produce more residual monomers.

Properties of acrylic resin

2. **Residual monomers:**

- The residual monomers released during service and result in:
  1. Irritation to soft tissues.
  2. Act as a plasticizer so deteriorate the mechanical properties.
  3. Increase surface porosity.

Properties of acrylic resin

2. **Residual monomers:**

- The chemical cured acrylic resin produces more residual monomers (3 : 5 %).
- Therefore, it is not preferred in denture construction.

Properties of acrylic resin

3. **Water Sorption:**

- Acrylic resin can absorb water and result is its expansion.
- After processing, the denture is immersed into water as water sorption results in 0.46% expansion which compensate the thermal shrinkage.

Properties of acrylic resin

3. **Water Sorption:**

- During service, the denture should be kept wet all times because drying the denture results in contraction. Continuous wetting and drying of the denture results in its crazing.

Properties of acrylic resin

4. **Solubility:**

- It is insoluble in most fluids contacting the oral cavity.
- Release of residual monomers results in some weight loss.

Properties of acrylic resin

5. **Mechanical Properties:**

- It has low mechanical properties.

Properties of acrylic resin

6. **Thermal Properties:**

a) Thermal Conductivity:

- It has low thermal conductivity so:
  i. Don’t produce physiologic stimulation to underlying tissues due to its heat isolation.
  ii. Don’t allow heat dissipation during processing results in gaseous porosity.

Properties of acrylic resin

6. **Thermal Properties:**

b) Coefficient of thermal expansion and contraction:

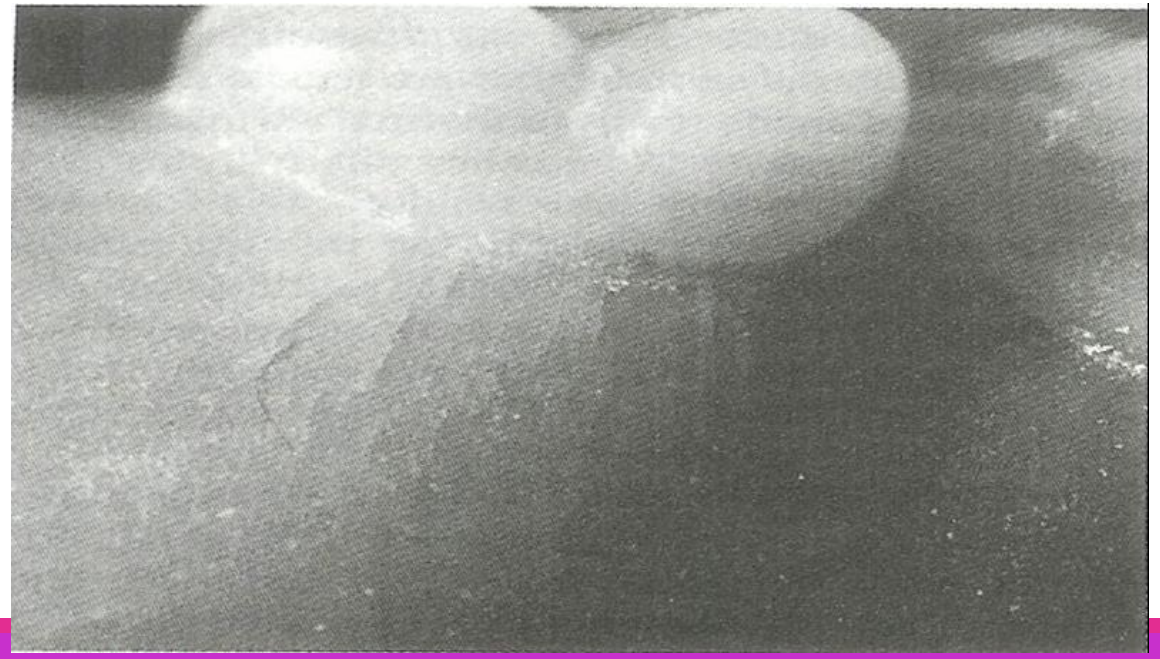
- It has high coefficient of thermal expansion and contraction which results in crazing if combined with porcelain teeth.

Properties of acrylic resin

7. **Crazing:**

- It is minute cracks appears on the surface of the denture that may coalesce resulting in larger crack and ends with denture fracture.

Fig. 2.—Crazing of acrylic tooth.



Properties of acrylic resin

7. **Crazing:**

- Causes:
  1) Mechanical stresses due to repeated wetting and drying of the denture (results in continuous expansion and contraction).
  2) Solvent action of the monomers during repair of the denture.
  3) Difference in coefficient of thermal expansion and contraction between denture base and artificial teeth.

Properties of acrylic resin

7. **Crazing:**

- Causes:
  4) Cleaning of the denture with bleaching agents or alcohol.
  5) Do not use of separating medium before packing.

Properties of acrylic resin

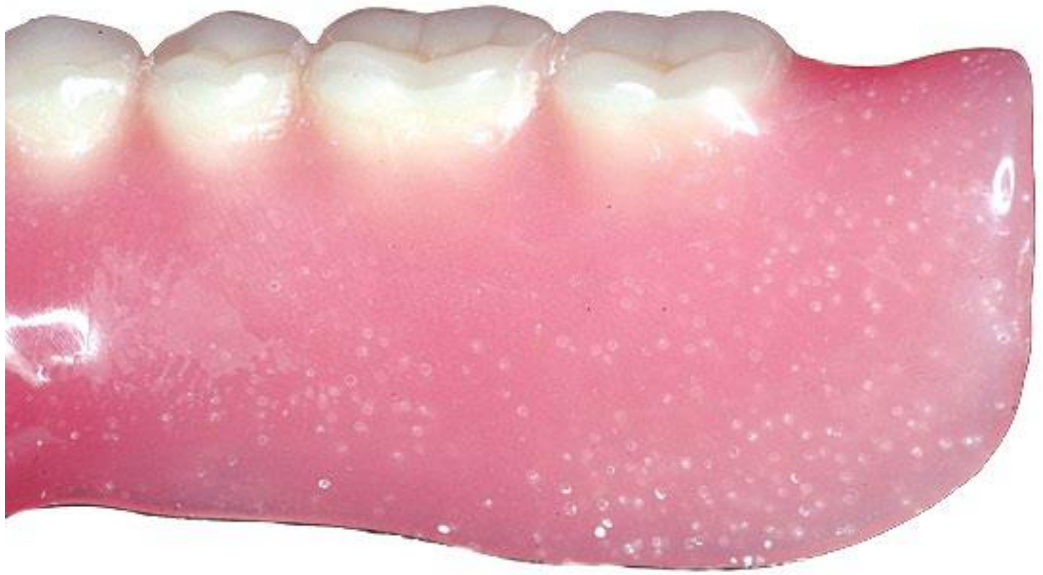
7. **Crazing:**

- Cross-linking decrease the chances of crazing.:

Properties of acrylic resin

8. **Porosity:**

- It has a deteriorating effect on the translucency and mechanical properties.



	Contraction porosity (Shrinkage porosity) (Surface porosity)	Gaseous porosity (Internal porosity)
Shape	Irregular voids	Round regular voids
Site	On the surface of the denture	In thicker sections of the denture (as tuberosity and lingual flanges)
Causes	1. Under packing. 2. Early packing (packing at sandy or sticky stages). 3. Use excessive monomer. 4. Don't use separating medium	Boiling and evaporation of the monomer due to high temperature of the water path (over curing) .

Modifications of acrylic resin denture base

1. **Microwave cured acrylic resin:**

- It is a modification of heat cured acrylic resin.
- Microwave oven produces the thermal energy required for polymerization reaction.
- It requires specially formulated resin and special nonmetallic flasks.
- The main advantage of this type is the speed.

Modifications of acrylic resin denture base

2. **High impact strength acrylic resin:**

- It is a modification of heat cured acrylic resin by incorporation of butadiene styrene rubber that can stop the crack propagation.
- This modification showed higher impact strength and facture resistance.

Modifications of acrylic resin denture base

3. **Light cured acrylic resin:**

- It consists of UDMA (urethane dimethacrylate) matrix with acrylic beads and silica.
- It supplied in sheets that is adapted to the cast then photopolymerized inside a light curing unit.

Modifications of acrylic resin denture base

4. **Fluid acrylic resin (pour type):**

- It is a modification of chemical cured acrylic resin but with smaller polymer beads size that results in high fluidity.
- The mix is poured inside hydrocolloid mold.
- Its main advantage is producing high surface details.

Modifications of acrylic resin denture base

5. **Rapid polymerized resin:**

- Its polymerization reaction is activated by chemical and heat ways.
- Its main advantage is rapid polymerization without porosity.

Modifications of acrylic resin denture base

6. **Flexible thermoplastic acrylic resin:**

- It is a modification of heat cured acrylic resin that overcomes some of its drawbacks as: high porosity, high water sorption, volumetric changes and residual monomers.
- Its advantages are accepting relining and repair easily and showed lower impact strength.

Modifications of acrylic resin denture base

7. **Polyamide (Nylon):**

- It is a thermoplastic flexible resin that shows more resistant to fracture.
- It Doesn’t bond chemically to acrylic resin (acrylic teeth requires mechanical interlocking and difficult to repair and teeth addition).
- It has high absorbency than acrylic resin (higher staining ability).

Thank You