Dental Materials

By

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Lecture No. (3)

Techniques of Denture Base Polymerization

Techniques of Acrylic Resin Denture Base Polymerization

According to mode of chemical reaction to free radical generation, various methods were presented for curing acrylic resin denture base materials. Therefore, classified as heat curing (water bath, microwave), chemical (self) curing, pour curing, light curing and thermoplastic (flexible) curing.

1- Heat Activated Acrylic Denture Base

The polymerization reaction of most materials required thermal energy and this can be obtained by using water bath or microwave oven. They found that no significant differences in these properties between the two curing methods. Powder /liquid ratio is 3:1, by volume or 2.5:1 by weight. The resultant mixture will pass into **five stages:** sandy stage, sticky stage, dough stage, rubber or elastic stage and stiff stage

A- Water Bath Curing

The type of the reaction is addition polymerization reaction (it is exothermic reaction), the resultant polymerization cycles have been quite successful for denture bases of various sizes, shapes and thickness.

A first technique involves long curing cycles processing the denture base resin in a constant temperature water bath at 74℃ for 8 hours or longer.

A second technique consists of long curing cycles processing of denture base resin in a 74℃ water bath for 7 hours and then increasing the temperature to 100℃ for 1 hour.

A third technique involves short curing cycles processing the denture base resin at 74℃ for approximately 1.5 hours and increasing the temperature of the water bath to 100℃ for 0.5 hour.

B- Microwave Curing

The acrylic resins are the same as used with bath water by using specially microwave for curing acrylic resin. Microwave can be used to generate heat inside

the resin. When processing (curing) of acrylic resins by microwave irradiation as electromagnetic waves produced by a generator are called a magnetron.

These (curing) processing faced some problems as reflection of microwave irradiation by metal flask, but when using non-metallic flask as plastic reinforced flask (PRF) was used to solve this problem, the results indicated that there was not reflection of microwave irradiation, and acrylic resin material was cured successfully.

The advantage of microwave curing processing is cleaner and processing time is faster (4-5 min) than the water bath polymerization processing, less residual monomer, less porosity, minimize dimensional changes, the physical properties and accuracy of acrylic resin be good as compared with water bath resin and chemical cured acrylic resin.

The proper choice of microwave, suitable microwave power and sufficient polymerization time is important in order to best curing of acrylic resin. Methyl methacrylate molecules are able to orient themselves in the electromagnetic field of the microwaves. Microwaves act only on monomer, which decreases in the same proportion as the polymerization degree increase. Therefore, the certain amount of energy is absorbed, and less when less monomer making for molecule chains increasingly.

2- Chemically (Self) Activated Acrylic Denture Base

The auto-curing denture base materials are chemically composition same as the heat cured denture base, varying only in the manner in which polymerization is initiated. In this type the powder contains small particles size of poly methyl methacrylate that have a lower molecular weight and contain benzyl peroxide as (initiator). The polymerization is initiated in manner similar to that describe for heat cure acrylic but is accelerated by chemical activation (catalysts), rather than by heat.

The chemically activated materials start to polymerization soon after the powder and liquid are mixed and progress more rapidly through the various stages.

When the powder contains the benzoyl peroxide is added to the liquid monomer that contains the tertiary aromatic amine as (catalyst) at room temperature which causes to decomposition of benzyl peroxide and produce peroxy free radicals, then promote initiate the polymerization of the monomer in the denture base material at room temperature, therefore called cold curing. After this type of curing the acrylic resin contains a proportion of residual monomer (un-polymerized monomer).

The color stability of chemically activated resins is related to the presence of tertiary aromatic amines which are susceptible to oxidation and accompanying color change that affect the appearance of the acrylic resin. Discoloration of these resins may be minimized by the addition of stabilizing agents should be added to prevent such oxidation. The composition and properties of heat curing and chemically (self) curing acrylic resins (PMMA) has been summarized in tables (1).

Table (1): Comparing Compositions of Heat Activated and Chemically (Self) Activated PMMA Resin.

Heat Activated PMMA Resin (Two Component System)		**Chemically (Self) Activated PMMA Resin (Two Component System)**	
Powder System		Powder System	
Poly (methyl meth acrylate)	Main constituent	Poly (methyl meth acrylate)	Main constituent
Benzoyl peroxide	Initiator	Benzoyl peroxide	Initiator
Mercuric sulphide Cadmium suplhide	Dyes	Mercuric sulphide Cadmium suplhide	Dyes
Zinc oxide, titanium oxide	Opacifiers	Zinc oxide, titanium oxide	Opacifiers
Dibutyl phthalate	Plasticizer	Dibutyl phthalate	Plasticizer
Dyed particles-glasses, beads	For aesthetics	Dyed particles-glasses, beads	For aesthetics
Liquid System		Liquid System	
Methyl meth acrylate	Plasticizes polymer	Methyl meth acrylate	Plasticizes polymer
Dibutyl phthalate	Plasticizer	Dibutyl phthalate	Plasticizer
Golycol dimeth-acrylate (1-2) %	Cross-linking agent	Golycol dimethacrylate (1-2) %	Cross-linking agent

Hydroquinone (0.006) %	Inhibitor	Hydroquinone (0.006) %	Inhibitor
		tertiary aromatic amine or amine sulfonic acids	Accelerators

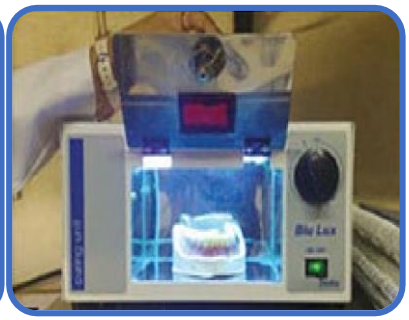
Compared properties of self-cure to heat-cure acrylic resin:

1- Low molecular weight due to (degree of polymerization not completed compared to that achieved using heat activated).
2- High residual monomer content (3-5%). While heat cured resin is reach up to 1%.
3- Low color due to (tertiary aromatic amine susceptible to oxidation).
4- Working time is longer than heat cure acrylic.
5- Less shrinkage than heat cures resin (lower dimensional change).
6- Lower hardness and transverse strength due to (residual monomer act as plasticizer).
7- Porosity in the cold cure resin is much greater than heat cure resin.
8- Relatively higher creep and deformation than heat cure resin.

3- Light Activated Acrylic Denture Base

As an amorphous polymer such as PMMA is highly transparent, rather brittle, high stable towards aqueous media and UV radiation. This system curing of denture base resin throughout use of radiation energy such as the visible light cured resin or infrared ray. Also, the argon laser was used for curing resin. The transverse, tensile and compressive strengths have been higher than those prepared by light curing.

This material is a composite of urethane di-methacrylate with PMMA copolymer, inorganic matters (silica fillers), inhibitors and light initiator for polymerization and is supplied as sheets in light proof bag like clay. This acrylic is polymerized in a light chamber (curing unit) with visible blue light (400-500 nm).

4- Pour Acrylic Resins (Fluid Acrylic Resins) Denture Base

The chemical composition of the pour type denture resin is similar to chemically activated acrylic resins. The pour type denture resin, commonly referred to as fluid resins, when mixed with monomer, the resulting slurry is very fluid. The mixture is quickly poured into modified plaster mold and allowed to polymerize under pressure. **Advantages of the fluid resin technique include:**

1. Short time consuming during curing processing.
2. Decreased probability of damage to prosthetic teeth and denture bases during deflasking.
3. Reduced material cost.
4. Simplification of the flasking, deflasking and finishing procedures.
5. Excellent reproduction of surface details.
6. Improved adaption to soft tissue.
7. Higher flexural bond strength.

While the disadvantages of the fluid resin technique include:

1. Air entrapment in the denture base material, which were attributed to incorrect pour positioning or to pouring resin that was too viscous.
2. Poor bonding the acrylic resin with teeth.
3. Teeth movement.
4. High polymerization shrinkage.

This type of acrylic resin takes the advantages of flow properties of polymer-monomer mixture at early stage. While the disadvantage of denture produced is less accurate because of high polymerization shrinkage, lower impact strength, lower fatigue strength, lower water sorption, higher solubility than heat cure type.

5- Thermoplastic Activated Acrylic Denture Base (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: thermoplastic acetal, thermoplastic acrylic, thermoplastic polycarbonate and thermoplastic nylon.

The Thermoplastic nylon is used as a denture base in every case specially used in partial and complete denture when have teeth undercut (because of the flexibility of the material) also used in tilted teeth, patient allergy to acrylic monomer, if there is reduced mouth opening and when we need high esthetic demand.

Chemically nylons are condensation copolymers formed by reacting equal parts of di-amide and dicarboxylic acid, water result as reaction by product. Usually, the thermoplastic nylon is supply as particles and prepared by injection molding technique, the injection temperature ranges from (274-293) ^{0}C. **The properties of thermoplastic nylon are:**

1. High mechanical strength.
2. Excellent flexibility and ductility.
3. It is semi translucent.
4. Light weight.
5. Provides excellent esthetic.
6. Nylon is tending to creep.
7. Difficult to polish and repair.
8. Minimal bonding strength to artificial teeth.
9. Lower water sorption than PMMA resin.
10. Good chemical resistance but they affect by strong acids and alcohols.
11. After short period of time dentures deteriorate, stain and rough surface.
12. Biocompatible (frees of monomer and metal which are the principle cause of allergic reaction).
13. High fracture resistance and impact properties, unbreakable martial (not fracture even if thrown from height).