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Application of Polymers in Denture and Its Developments

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Abstract:
In dentistry, polymer plays vital role in denture. Development was made from decades to decades still ideal denture has not been made in dentistry. The efforts are ongoing in regard to process in RRP (Rigid Rod Polymer) to develop ideal denture. But the PMMA poly (methyl methacrylate)] is still a superior choice of prosthetics and less expensive and usage was found to have good durability.

I.INTRODUCTION

An important and growing part of the textile industry is medical textile showing total usage of textile product is 9%. The aim of this article is to discuss variety of products currently used and their properties that make suitable for this application with reference to the ideal requirements of denture as follows:

Property	Requirements
Biological	Toxicity, Biocompatibility Hydrophobicity,
Chemical	Solubility in different fluids and oral fluids Hydrophobicity
Mechanical	Dimensional stability. Good adhesive property. It should be good rigidly property for masticator It should be resistant or low elastic property It is tissue friendly good abrasion strength specific gravity should be low for auxiliary denture.
Thermal	Good thermal conductivity Optimum Co-efficient of thermal expansion[COTE] Glass transition temperature (Tg) of the polymer should be high as compare to water (boiling temperature)
Esthetical	Optically translucency should be good like glass. It should be able to tint or pigmentation for coloration
Others	Good durability, low expensive, easy to manipulate, easy to clean and repair radio opaque. Good if any uneven damage of denture.

Denture base materials are classifieds into four major groups namely 1.Metals. 2. Ceramics. 3. Composite. 4. Polymer materials. The present article deals with anthology of polymer used in dentures. Polymeric dentures which are classified as,

1. Linear polymers
2. Cross linked polymers
3. Rigid Rod polymers

II. LINEAR POLYMER MATERIALS.

In linear polymer category, PMMA ploy (methyl methacrylate)] plays major role in fabrication of complete or partial dentures. In addition, denture soft tissues resin cements, pit and fissures sealment also consists of polymer. The PMMA polymer denture is most popular choice of prosthetic device. In complete denture constructed with some precious metal alloys and base metal alloys in previous days. The following chart will show the usage of polymers with development. Fig.1 shows the sequence of development of denture materials over the past several years.

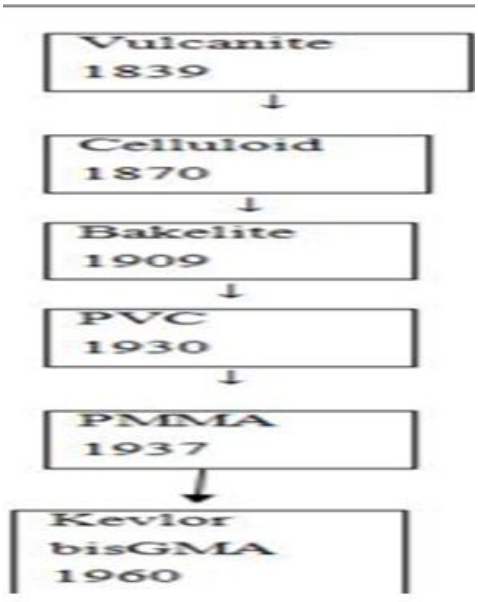

Figure.1.Development of denture raw material over the years

i. Vulcanite

The first invention of polymeric denture base resin is vulcanite. In 1839, Charles good year introduced. Vulcanite formed by addition of natural rubber and sulphar under the steam pressure at 160^{0}C to 170^{0}C. The sulphar helps the cross linking of polymeric rubber to form a rigid, opaque and stable material. In vulcanite sulphar helps the rubber to get heat resistance, high melting point and more resistance to oxidation as compared to native natural rubber. But, vulcanite fails get opaqueness and resistance to oral fluids resulting in as unhygienic for base denture material.

ii. Celluloid

Celluloid base material was introduced during 1870. The celluloid material can be used by plasticizing cellulose nitrate with camphor after which the pigmentation is carried out. A denture material is constructed by processing the celluloid blank into dry, heated mould. But, it fails because of absorption of water and staining from food, drinks and tobacco. The residual camphor material in denture makes the patients feel uncomfortable and also difficult to repair fracture indenture.

iii. Bakelite [phenol formaldehyde]

In 1909, Dr. Leo Backelan, Belgian chemist, discovered it and it was used till 1924. This Bakelite base material produced by condensation method condensing one or more types of phenols with formaldehyde and it has excellent aesthetic property but this base material gets stained in early usage and it is more brittle and prone fracture. It is more difficult to repair and having poor shelf life.

iv. Polyvinyl chloride [PVC]

PVC base material process is similar to celluloid process with co-polymer of vinyl chloride (80%) and vinyl acetate (20%). It was introduced in the year 1930. PVC is using currently as linear material in dentures and athletic mouth guards. PVC is plasticized with either dibutyl or dioethylphthalate. PVC is available as plasticized sheet which can be used to construct protective mouth guards. Processing generally involves heating the pre-plasticized sheet followed by molding it to the desired contour with the use of vacuum to seal the sheet of material over a cost of the patient's teeth. It also fails because of hardening over the time as the plasticizer leaches out during service. In addition, it is difficult to get polished. This results in poor denture hygiene and acts as an irritant to the oral mucosal tissue.

iv.i Poly (methyl methacrylate) [PMMA]

The Walter Wright introduced this as superior material for denture in 1937. The new material such as polystyrene and light activated methacrylate were introduced PMMA is the polymer of methyl methacrylate chemical formula (C5H8O2)n is clear and colorless polymer. Acrylonitrile [90-94%] combined with at least one or two monomers.

iv.ii. There are 2types of polymerization methods for PMMA base denture There are three methods of polymerization used commercially.

A. Solution B. uspension

The suspension method of PMMA polymerization (Fig.2) was used in dentistry as base material. PMMA formed by the presence of benzyl peroxide (BP) while polymerization of BP breaks down to produce free radicals, opening the double bond leading to formation of new single bond C-C. The free radical formed from the methacrylate double bond is asymmetrical. This results in a carbon atom that was on asymmetrical. The resulting polymer is atactic.

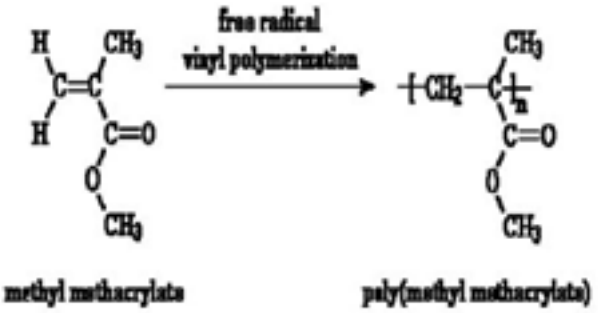

Figure.2. Polymerization of PMMA

iv.ii Properties of PMMA polymer

a. Trade name: PMMA, Plexiglas, Lucite
b. Properties: optically clear (92%) transmission theoretically limits for normal incidence rough the visible wavelength range very little UV absorption limit 260nm.
c. Good mechanical property.
d. Good weather-ability
e. High sensitivity to electron radiation

Applications:

a. Replacement of glass
b. Can be used as one component- deep UV.
c. Electron beam or beam-in resists manufacturing microchips.

iv.iii [PMMA] polymer base dentures are categorized on manufacturing methods

- Light activated PMMA denture
- Heat activated PMMA denture
- Chemically activated PMMA denture

iv.iiia. Light activated resins

Light cured composite materials include adhesives, light cured glass-monomer cements, usually one component: It is Methacrylate resin, light initiating system camphor Quinone (CQ)- amine, inhibitors Filler particles: LIGHT ACTIVATED, with UV absorption at 268nm

iv.iiib. Heat activate PMMA denture

These materials are widely used for the manufacture of removable complete or partial denture. The polymerization process is initiated by the release of free radical from benzyl peroxide on supply of heat energy. In this process two forms of polymers are used one powder and another form liquid. Powder contains Pre-polymerized PMMA beads and liquid contains methyl methacrylate (PMMA). The liquid is stored in a dark brown closed container to avoid accidental polymerization when exposed to visible or UV radiation. Table 1 gives the manufacturing process of heat activated PMMA denture.

iv. iiic Limitations of Heat and light activated PMMA denture and properties

Potential to elicit irritation, inflammation and allergic response of the oral mucosa residual monomer is capable of producing both stamatitis and an angular cheilitis.

- Residual monomer present in heat cure acrylic resin is 0.2-0.5% and in self-cures acrylic resin. It is 2-5 % residual monomers effect of leached tissues and vitro cell growth.

- ormaldehyde is another allergic agent in acrylic denture responsible for mucosal injuries. Formaldehyde is formed as on oxidation product of a residual MMA [methyl methacrylate] in inhibition layers and poorly polymerized resins.

The cytotoxic effects of acrylic resins were greater in the 24hr after polymerization and decreased with time. Therefore, the longer a denture is soaked the less cytotoxic effect irrespective of type of the denture base resin used. Table 1 gives the typical properties of the PMMA.

Table.1.Properties of powder and Liquid heat and light activated PMMA

Powder form	Liquid form
Pre- polymerized poly (methyl methacrylate). Co-polymers of PMM(5%) eg: ethyl or Butyl Initiator (0.2%-1.5%). Eg: Benzyl peroxide Color pigments. Eg: mercuric sulphide cadmium sulphide, ferric oxide, carbon black Opacifier. Eg: zinc or titanium oxides Inorganic particles. Eg: glass fiber zirconium silicate. Whiskers of aluminium, sic,boron nitride and carbon fibres Heavy metal compounds. Eg: Barium, bismouth etc.	Methyl methacrylate co-monomer Initiator. E.g.: Hydroquinone (0.003%- 0.1%) Plasticizer. Eg: Butyl or oct methacrylate Cross linking agent. Eg: Ethylene glycol dimethacrylate.

iv.iv Chemically activated PMMA denture

PMMA denture or polymerization called chemically activated PMMA denture are manufactured using N, N, - Dimethyl P-Toludene and polymerization reaction takes place at ambient temperature. This was discovered at the time of world war-II in Germany. It is called as self-cure or cold cure auto in polymerization PMMA denture. The process of chemically activate resin given at Table 2

Table.2. Properties of Chemically activated PMMA

Powder	Liquid
Poly methyl methacrylate co-polymer beads	Methyl methacrylate monomer Ethyl glycol dimethyl Di-methacrylate
Initiator Benzyl peroxide maximum-21	Cross-linking agent Tertiary amino (dimethyl para toudene)
Pigment colored fiber Esthetic effect nylon or acrylic	Activator (maximum-0.75%)

iv.iva. Limitations of chemically activated PMMA denture

Unlike heat curing resins, the polymerization of self- curing resins is never complete, self-cured resins are composed of 5% residual monomer. The irritation of tissues may be released from the denture and oral tissues. Residual monomer will act as a plasticizer and makes the resins more flexible (decreased transfer strength)

- Less shrinkage than their heat activated counter parts, because of incomplete polymerization.The color stability is inferior to that of heat activated resin.

Tertiary amines base activator present in the resin is susceptible to oxidation and accompanying color changes that may affect the appearance of denture. Organic compound improves color stability but the compounds are not chemically stable.

iv.iv.b. Properties of chemically activated PMMA denture base material.

Table.3. Properties of chemically activated PMMA denture material

Solubility	In aromatic hydrocarbons ketones and esters	0.04mg/cm
	In water	0.02mg/cm^{-2}
Modulus of elasticity		3.8x10^{-3}
Proportional limit		26mpa
Comprehensive strength		76 mpa
Tensile strength		48-262 mpa
Elongation(%)		1-2%

Import strength	0.98-1.27J
Surface hardness	18-20KHN
Density	1.16-1.18g/cc
Thermal conductivity	5.7x10^{-40}ckm
Efficient or thermal expansion	81x10^{-6} /^{U}C
Transition temperature	125^{U}C
Polymerization temperature	450^{U}C
Distortion temperature	70-91/^{U}c

Table 3 gives the typical values of various properties of the chemically activated PMMA denture material. It is hence expected that the material properties are met with for satisfactory functioning of the material. Further, the biological properties are equally important as the material is used in conjunction with human body under semidry fluid medium. Fig.3 shows the details of the laboratory steps involved in the complete removable denture material in unconventional techniques.

Cross linked polymers used in denture base material

Polymers are composed of carbon chains which are linked together by strong chemical covalent bonds cross linked polymers cannot be formed by heat and it is also more difficult to dissolve them into solvents.cross linked polymers used in denture are bisphenol-A- glycodyldimethacrylate (Bis GMA), triethyl Glycoldimethacrylate (TEGDMA), Urathaned dimethylate (UDMA), Hydroxyethyl metha crylate (HEMA), hydrophilic monofunctional monomer.

IV. RIGID ROD POLYMERS (RRP)

All of the polymeric materials in dentistry are not ideal for their clinical use. Hence it is desirable to explore new materials

and develop techniques in dentistry use. RRP could be used as new material and develop technique in dentistry because of good mechanical, crystillinite properties. These properties of RRP are limited to usage. The well-known RRP is Kevlar fiber. RRPare by and large are having aromatic carbocyclic heterocyclic structure. The Kevlar polymer has been, despite good mechanical properties and crystallinity, difficult to dissolve in solvents to convert them into denture material.

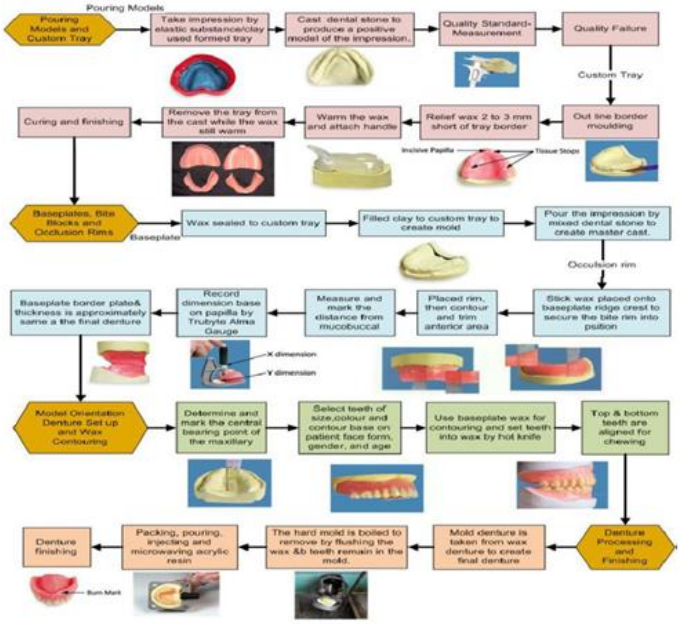

Figure.3. Details laboratory steps of removable complete denture unconventional technique.

V. CONCLUSIONS

Medical textile is emerging as an important sector of technical textiles showing promise to innovate newer polymers for various applications including denture polymeric material. Polymers used in Denture have direct bearing on the performance properties. Estimated growth of medical textiles is envisaged as 12% per annum and Denture application is small portion of it. Since its application is in direct contact with human body under fluid conditions various properties in terms of chemical, mechanical and biological characteristics are extremely important.

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