Polymers used in Dentistry: An Overview Of Literature

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Abstract

The expanding use and enthusiasm for dental polymer aren't just ascribed to the brilliant surfaces of polymers yet besides their ideal mechanical and organic properties, minimal effort and simplicity of dealing with while preparing for a wide scope of utilizations. Polymers, for example, acrylic acid copolymers are utilized as a dental adhesive; polylactic acids are utilized for dental pulp & dentin recovery and bioactive polymers are utilized as advanced drug delivery systems. The article aims to audit the writing on the headways in the utilization of PMs in dentistry.

Keywords: *Denture base polymer,Polymeric composites, Bonding Agents*

Introduction

Before the introduction of acrylic polymers to dentistry the principle polymers used was vulcanized rubber. Polymers introduced in 1937 included vinyl acrylics, polystyrene, epoxies, polycarbonates, polyethylene, polyvinyl acetate, polysulfides, polysilicon, polyethers, and polyacrylic acids. The primary use of polymers has been the construction of prosthetic appliances such as denture base. However they are also used in artificial tooth, restoration, cements, elastics, inlay patterns, implants, impression materials, dies, temporary materials, endodontic filling etc.

Polymers are shaped through compound responses that convert an enormous number of low sub-atomic weight (LMW) particles known as monomers into a huge exceptionally high sub-atomic weight chain full-scale atoms known as polymers the structure and morphology of this large scale particle decides if the material is a fiber,an unbending strong or an elastomer.

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Table 1. Classification of Polymers

Based on the nature of monomer	Homopolymer
	Copolymer
Based on the nature of monomer	Linear
	Branched
Based on Spatial arrangement	Addition
	Condensation

Dental uses of polymers:

The various uses of polymers in dentistry are as follows:

- "Prosthodontics"-"Denture bases and teeth, delicate liners, custom plate, impression materials, core build-up materials, temporary restoratives, establishing/luting materials, and maxillofacial prostheses".
- "Operative Dentistry"- "Dentin bonding agents, cavity fillings, resin and glass-ionomer cements, pit and fissure sealants, bracing materials and veneers".
- "Orthodontics"- "Brackets, bracket holding adhesives and cements and spacers".
- "Endodontics" - "Gutta-percha, root canal sealants and elastic dams".
- "Equipment"- "Mixing bowls and spatulas, mouth guards (athletic gear) and defensive eyewear".

Properties of Polymers:

Mechanical and Physical Properties of Polymers: The blend of polymer creation, chain length, spreading, cross-connecting and nuclear heading can convey a grouping of properties. To address the issues of various dental applications, these features are controlled to make a decent property. These properties can be assembled into four interrelated groupings: "Mechanical, Rheological (Flow), Dissolution and Thermal".

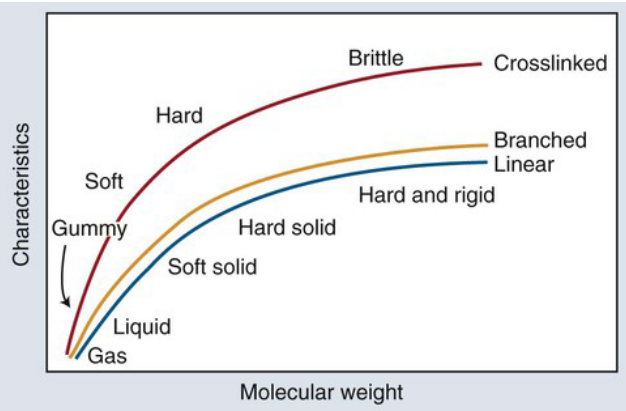

Fig. 1: Rigidity,strength and melting temperature increases with increase with molecular weight and chain length(courtesy-Phillips science of dental material)

Mechanical Properties—Deformation and Recovery: When forces are applied to the polymer they produce stress which causes materials to deform or stretch from its original shape and size (i.e, undergo strain) via either "elastic strain, plastic strain or a combination of elastic plus plastic strain".

- "Plastic strain"- Plastic strain is irreversible distortion that can't be recovered and realizes another, unending shape as the eventual outcome of slippage (flow) among polymer chains.
- "Elastic strain"- Is a reversible,versatile strain that is quickly and completely recovered when the pressure is wiped out, as the aftereffect of polymer chains uncoiling and afterward pulling back.
- "Viscoelastic strain"- Is a mix of both adaptable and plastic deformation, yet simply the flexible part is recovered when the weight is decreased.

Rheometric properties: The rheometry or flow behavior of rigid polymers involves a mix of elastic and plastic deformation followed by elastic recovery after the stresses are removed. This combination of elastic and plastic changes are called viscoelastic property.

The length of the chain,cross link numbers,temperature, and rate of force application determines which type of behavior dominates.

- Plastic flow- Irreversible strain conduct that happens when polymer chains slide more than each other and get moved inside material bringing about perceptual distortion.
- Elastic recovery- reversible strain behavior that occurs in amorphous regions of polymers when randomly coiled chains straighten and then recoil like springs.

Solvation and Dissolution properties: Polymers are usually slow to dissolve the salvation characteristic is very sensitive to polydispersity,cross linking,crystallinity, and chain branching the following characteristic properties exhibited by polymer which is relevant in dentistry-

- The longer the chains with high molecular weight the less is the solubility of the polymer.
- Polymers engross a solvent and soften, but they never dissolve.
- The cross-connecting of the chain forestalls chain detachment and retards disintegration and exceptionally cross-connected chains can't be broken down.
- Elastomers swell more effectively than plastics.
- Absorbed molecules spread the polymer chain within the polymer thus facilitating the slippage of chains and this property is called plasticization.
- The swelling of dental polymers affects the fit of dental polymeric prosthesis.

Thermal properties: The property of a polymer changes with change in temperature and composition,structure, and molecular weight. Thus higher is the temperature the softer and weaker the polymers become. Polymers can be formed into desired shapes using a type of polymeric material used. According to its thermal setting polymer can be divided into thermoplastic polymers and thermosetting polymers.

Thermoplastic polymers: Soften on heating and hardens on cooling. The rmoplastic polymers are made up of branched or linear chains and they soften when heated above the "glass transition temperature(Tg)". Eg-polyamides (nylon), acetal resins, epoxy

resins,impression compound,polystyrene, polycarbonate resins, polyurethane, and acrylic.

Thermosetting polymers: Thermoplastic material undergoes a series of chemical changes and hardens when heated above the glass transition temperature. The y don't soften again on reheating. The y usually are cross-linked in this state and don't melt.Eg-PMMA.

Applications of polymers in dentistry-

Denture Base Material: "Most denture bases and acrylic teeth are manufactured utilizing (polymethyl methacrylate) PMMA".Pmma is much of the time utilized because of its different preferences like low cost,biocompatibility,ease of processing,stability in oral condition, and worthy esthetics.How ever the properties of Emma is upgraded by joining numerous fillers and fibers.

Soft Lining Materials: These are predictable materials that are made to set between the denture and the oral mucosa to lessen torture and misery achieved by hard dentures. These materials are also applied in maxillofacial remaking as obturators". Delicate (soft relining) covering materials are classed in two sorts: delicate acrylics and silicone rubbers.

Warmth or room temperature polymerized methacrylates with included plasticizers, hydrophilic acrylic polymers, silicones, and elastomer/methacrylate copolymers are commonly used as soft lining materials. A fundamental essential is a glass temperature underneath 37 °C, with the ultimate objective that the polymer remains sensitive in the oral pit. The polymers should be biocompatible, nondisturbance to oral tissues, have palatable mechanical quality, and have low fluid take-up.Soft acrylics show extraordinary attach to PMMA dental replacement bases exactly as expected in any case the joining of plasticizers adds to, the cementing over some interval and they furthermore experience the evil impacts of tremendous water take-up. There is a creating stress over the use of Phthalate plasticizers, as a result of their hurtfulness. Silicones experience the evil impacts of nonappearance of cling to the acrylic dental replacement bases and have a low assurance from tear.

Some silicone delicate liners acclimatize a great deal of fluids and water take-up of hydrosilanized silicone rubbers is influenced by included substances, for instance, hydrophobic or hydrophilic silica and is related to the dissolvability of the additional substance, increasingly conspicuous dissolvability offering climb to a drawn-out water take-up with greater deviation from customary dispersal qualities.

Dental Composites: Dental composites are tooth-colored filling materials made out of "engineered polymers, particulate ceramic fillers, polymerization promoters and coupling agents". The y are logically being used as helpful materials set clearly, in an indirect route or as concrete, inbonded rebuilding efforts. Dental composites are provided as single paste details likewise named "visible light cure(VLC) materials and as two paste for the self-cure systems".

Dentin Bonding Agents: Other than GIC, bulk filling material don't adhere to tooth and Dentine bonding agents give an extraordinary joining to tooth structures just as the new age materials similarly permitting bonding between composite resins and substrates, for example, base metal combinations, solidified amalgam, cured composites and porcelain. Dentine bonding agents can be considered to incorporate three segments:"a primer, a coupling agent and an unfilled resin" critical to obtain an exact impression followed by its adaptable recovery and mechanical quality.

All the more as of late, a helpful cement was blended that contained three operators: "a QAM named dimethylaminododecyl methacrylate (DMADDM) with antibacterial movement, nanoparticles of silver (NAg) and NACP for remineralization". There was no lessening in dentin bond quality from one day to a half year of when put in water, while the commercial control bonding agents lost quality generally 33% of its dentin bond quality at six months.bonding agent demonstrated a drawn-out sturdiness in dentin bond quality.

Impression Materials: Various strategies in restorative dentistry require a precise imitation cast of the oral soft and hard tissues to construct appliances outside the mouth; a couple of models being dentures,crowns and bridges, and orthodontic appliances. Impression materials are placed in the oral cavity in a plastic or fluid state which in this way experiences a progression of chemical reaction. The flow properties are critical to get an exact impression followed by its adaptable recovery and mechanical quality. Impressions are much of the time put away at room temperature and exposed to high tensile stress on expulsion from undercut regions. Eg-natural polymers agar-agar,silicone impression material, polyethers, polysulphide.

Peek and Peak: PEEk (polyetheretherketone) is an artificially produced polymeric material and the most critical agent of polyaryletherketone (PAEK). This is a somewhat crystalline, thermoplastic high temperature-resistant, high-performance plastic with a softening temperature of 334°C. In this manner, PEEK can be utilized in pressurized pressure frameworks like the "for 2 press" framework, while the industrial facility squeezed items can be prepared with various cutters and utilized in "computer-aided design/CAM"technology.

PAEK is a tolerably new gathering of high-temperature thermoplastic polymers involving a key sweet-smelling fragrant atomic steel by "ketone and ether". The manufactured structure of polyaromatic ketones gives soundness at high temperatures (more than 300°C), making it incredibly charming for current applications. Before the completion of 1990, PEEK had created as the key thermoplastic polymer and was used to supersede metal parts in the orthopedics. PEEK can without a very remarkable stretch be adjusted by including various materials carbon fiber expansion may assemble the versatile modulus to 18 GPa. The carbon-braced PEEK module is contrasted with the cortical bone and the dentin. The versatility of PEEK resembles that of bone, polish, and dentin in this way making it a perfect material for interminable prosthetic modifying endeavors.

Bio HPP: Bioactive PEEK with ceramic filler (Bio-High Performance Polymer) is a piece of the "PEEk" family and is applied in medical procedures since a significant time allotment. In light of its incredible soundness, its optimal cleaning properties, and its low plaque affinity, BioHPP is commonly phenomenal for definite prosthetic recoveries fabricate. "The biopolymer has a modulus of adaptability closer to the human bone and this reality improves the chewing performances. BioHPP (High-Performance Polymer) is an inventive thermoplastic polymer reliant on PEEK". It was made and upgraded for dental use. It contains ceramic microparticles for better cleaning of the reclamations. These ceramic fillers have a size of about 0.3-0.5 microns and have 20% of the hard and fast volume of BioHPP.

BioHPP is as close as conceivable deep down, on account of its coefficient of versatility (around 4 GPa). This is significant in implant treatment in situations when winding powers may happen. The biting pressure is transmitted as tenderly as could be expected under the circumstances, and the danger of fracture is decreased, because of the BioHPP modulus of flexibility near that of the spongiose bone.

BioHPP is especially appropriate for patients with sensitivities because the solvency of the polymer in water is low <0.3 ìg/mm^3. Studies exhibit high protection from abrasion. BioHPP can be an option in contrast to chromium-cobalt dental alloys (Cr-Co) since it is lighter and doesn't cause erosion. BioHPP developments can be built utilizing both current CAD/CAM innovation and standard wax substitution innovation.

Application of Bio-HPP: Removable Partial Dentures, Crown And Bridge Fabrication, Individual Implant Abutments.

Fig-2: BIO-HPP as framework

Polymers in Implantology: The osseointegration of cpi/Ti implants used for dental, craniofacial, and orthopedic explanations behind existing is related to their course of action and surface harshness. Rough surfaced implants increase osseointegration and biomechanical stability".Implant surface treatment systems join "Ti plasma-splashing,grit blasting,acid etching, anodization and calcium phosphate coatings. A perfect situation is fundamental for embed osseointegration. The diminished oxygen obsession from the poor vasculature at the embed surface interface propels the advancement of host-cell-related electrons as free radicals and proton destructive that can engage disease and irritation causing implant failure. To give a decent ideal condition for osseointegration and overcoming the issues related toTi inserts, surface alterations can be performed using great fiber-reinforced and complex fillers/included substances including hydroxyapatite or antimicrobial circuit by method for thermoset polymers. The polymer/carbon-fiber composite conveyed powerful osseointegration. The rmoset polymer cross-section and carbon strands

make covalent bonds outfitting strong bone structure support with mind-blowing osseointegration. The utilization of anti-infection containing nanofiber put together polymeric films concerning dental implants has been explored to limit implant failure,particularly in periodontally undermined patients.

Conclusion

Plastics are employed successfully in many dental applications. Their properties make them valuable especially in the construction of dentures, plastic teeth, and impression materials. Plastic filling materials have not been successful because of their high coefficient of thermal expansion and lack of bonding to tooth structure. Perhaps the biggest improvement in filling materials would be the development of a satisfactory cavity liner that bonds to tooth structure and is impervious to the mouth fluids. If such a liner were available, the need for a filling material that matches the thermal expansion of the tooth would be less critical. With advancement in higher physical and mechanical properties of polymers, it is now used along with implants and also bridge and crown prosthesis. Although the economical issues cannot be ruled out with this improved material.

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