THERMOPLASTIC RESINS FOR FLEXIBLE FRAMEWORK REMOVABLE PARTIAL DENTURES

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REZUMAT

Utilizarea terapeutică a materialelor termoplastice a crescut semnificativ în ultimul deceniu. Aceste proceduri noi, prin care un material complet polimerizat este plastifiat prin prelucrare termoplastică (fără a aduce modificări chimice) și apoi injectat într-un tipar a deschis un nou capitol în tehnologia protezelor mobile și mobilizabile. Biocompatibilitatea excelentă și proprietățile mecanice superioare ale acestor materiale pot fi obținute doar printr-o prelucrare technologică corespunzătoare. Aplicațile actuale ale materialelor termoplastice în medicina dentară includ: croșete preformate, proteze parțiale mobilizabile cu bază flexibilă, coroane și proteze parțiale fixe provizorii, șine ocluzale, stâlpi implantari, dispozitive ortodontice etc. Prin dezvoltarea de noi combinații de elastomeri și copolimeri este sigur că vor apărea multe aplicații clinice noi ale rășinilor termoplastice în medicina dentară.
Cuvinte cheie: Rășini termoplastice, proteze parțiale flexibile, sisteme de injectare

ABSTRACT

The therapeutic use of thermoplastic materials has increased drastically in the late decade. This new procedure, during which a fully polymerized basic material is softened by heat (without chemical changes) and injected afterwards, has opened up a new chapter in making dentures. The excellent tissue-friendly and mechanical characteristics of these basic materials can only be made to last by an exactly executed and reproducible technology. Current dental applications of thermoplastic materials include: preformed partial denture clasp, flexible tooth born partial denture framework, single cast partial dentures, temporary crowns and bridges, provisional crowns and bridges, occlusal appliances, implant abutments, orthodontic and sleep apnea appliances, many of which have been described previously. However, with the development of new elastomers and copolymer alloys, there are certain to be many new clinical applications for thermoplastic resins in dentistry.
Key Words: Thermoplastic resin, flexible framework RPD, injection system

INTRODUCTION

If you are missing only a few teeth scattered over either arch (upper or lower teeth), or even if you have a minimum of two teeth on both sides of the arch, then you can most inexpensively replace the missing teeth with a removable partial denture (RPD). There are several types of RPD's.[1] All of them use standard denture teeth as replacements for the missing natural teeth. The differences between them are the materials used to support the denture teeth and retain the RPD in the mouth.[2]

The application of nylon-like materials to the fabrication of dental appliances. has been seen as an advance in dental materials. This material generally replaces the metal, and the pink acrylic denture material used to build the framework for standard removable partial dentures.[3]

Thermoplastic materials for dental prostheses, Valplast (Valplast Int. Corp. - USA) and Flexiplast (Bredent - Germay), were first introduced to dentistry in the 1950s. Both materials were similar grades of Polyamides (nylon plastics). Since their introduction, there has been a continued interest in thermoplastic dental materials.[4,5]

Rapid Injection Systems (currently known as The Flexite Company - USA), originated in 1962,

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introduced the first Flexite thermoplastic which was a flouropolymer (a Teflon-type of plastic).[6]

Valplast introduced a flexible semi-translucent thermoplastic resin to create flexible tissue-born partial dentures. While the material was not strong enough to allow for conventional tooth born rest seat, the flexibility added to patient comfort in wearing the appliances.[5]

Flexite also was early into the dental market with flexible thermoplastic acrylic hybrid resin for removable appliances. Acetal was first proposed as an unbreakable thermoplastic resin removable partial denture material in 1971. It was during this period that Rapid Injection Systems developed the first tooth-colored clasps with a thermoplastic fluoropolymer.[7]

In 1986, Dental 'D' reintroduced tooth-colored clasps using Acetal resin. The clasps were flexible, did not need periodic adjustment to keep them tight, and the tooth colored esthetics were appreciated by the patients. Pressing Dental followed in the early 1990s with an Acetal resin, (marketed in the U.S. by DENTSPLY Austenal), which in addition to tooth colored clasps, has been used for an entire partial denture framework as well as other appliances.[8]

In 1992, The Flexite Company, developed and patented the first pre-formed tooth-color clasps known as Clasp-Eze. This product, made of a nylon material, is available in pink and clear color shades and currently sold worldwide.

DENTSPLY recently introduced the Success FRS, "flexible resin system" for their Success denture press. The FRS system utilizes a flexible tissue colored thermoplastic resin for flexible partial dentures. Currently Cosmetic Dental Materials, has introduced Aesthetic PerfectionT (patent pending), a new line of thermoplastic Acetal, Acrylic, and Polycarbonate materials that can be used in most thermoplastic presses. These materials offer excellent esthetics combined with favorable physical properties and easy processing characteristics.[5]

ADVANTAGES OF THERMOPLASTIC MATERIALS

Thermoplastic resins and co-polymers have many advantages over conventional powder or liquid resin systems. Thermoplastic resins tend to have predictable long-term performance. They are stable and resist thermal polymer unzipping. They also exhibit high creep resistance and high fatigue endurance as well as excellent wear characteristics and solvent resistance. Thermoplastic resins typically have very little or almost no free monomer in the material. A significant percentage of the population is allergic to free monomer and these materials offer a new safe treatment alternative for these individuals. In addition, thermoplastic materials have almost no porosity, which reduces biologic material build up, odors, and stains and exhibit higher dimension and color stability. All of these factors become important when producing long-term provisional prostheses during implant or complex restorative cases, or when used for permanent removable appliances. Typically, the thermoplastic resins are more flexible and stronger than their traditional counterparts are. Elastomeric resins can be added to the resin polymer formulas to create greater flexibility, which reduces fracturing. Thermoplastic resins can also be reinforced with glass filler or fibers to further enhance their physical properties.[9] At the same time, these restorations can be relined and repaired, by repressing the restoration. The thermoplastic resins can produce single cast or pressed restorations that are strong, lightweight, flexible appliances in tissue or tooth color matched materials that never need adjusting. These restorations display excellent esthetics and provide long-term comfortable use for the patient. This provides excellent alternative cosmetic restorations for esthetic-conscious patients. Thermoplastic resins are used for a broad variety of applications from removable flexible partial dentures, preformed partial denture clasps, fiber reinforced fixed partial dentures temporary crowns and bridges, provisional crowns and bridges, obturators and speech therapy appliances, orthodontic retainers and brackets, impression tray[10] and border molding materials[11], occlusal splints, sleep apnea appliances, and implant abutments.

THERMOPLASTIC ACETAL

Acetal as a homo-polymer has good short-term mechanical properties, but as a co-polymer has better long-term stability. Acetal resin is very strong, resists wear and fracturing, and is quite flexible. These characteristics make it an ideal material for pre-formed clasps for partial dentures, single pressed unilateral partial dentures, partial denture frameworks, provisional bridges, occlusal splints, and even implant abutments. Acetal resins resist occlusal wear and are well suited for maintaining vertical dimension during provisional restorative therapy.[5]

While stronger, Acetal does not have the natural translucency and vitality of thermoplastic acrylic and polycarbonate, and these materials might offer better results for short-term temporary restorations.

THERMOPLASTIC POLYCARBONATE

Polycarbonate is a polymer chain of bisphenol-A carbonate. It is a popular material and has been used in dentistry for a long time as preformed temporary crown shells. Similarly to Acetal resin, polycarbonate resin is also very strong, resists fracturing, and is quite flexible. However, polycarbonate does not wear as well as Acetal during occlusal force and consequently will not maintain vertical dimension as long. Polycarbonate is ideally suited for provisional crowns and bridges but not suitable for partial denture frameworks. The material has a natural translucency and finishes very well, yielding excellent esthetics. Temporary and provisional restorations with thermoplastic polycarbonate provide patients with excellent short or mid-term function and esthetics.[7,12]

THERMOPLASTIC ACRYLIC

Acrylic is better known as polymethyl methacrylate or PMMA. This material has been used in dentistry for many years in the form of temporary crowns and thermal polymerized as baseplate material for partial and complete dentures. Thermal polymerized PMMA demonstrates high porosity, high water absorption, volumetric changes and residual monomer. These properties lead to many of the problems associated with thermally polymerized acrylic versus the thermoplastic version.[12] Thermoplastic acrylic has poor impact resistance, but has adequate tensile and flexural strength for a variety of applications. The material is easy to adjust, handle and polish. It is relineable and repairable at the chair-side. Thermoplastic acrylic is available in both tooth and gingival colors, and has both translucency and vitality, providing excellent esthetics. Like most thermoplastic resins, acrylic resin is also strong, resists fracturing, and is flexible.[7,13] However, acrylic does not wear as well as acetal during occlusal forces and consequently will not maintain vertical dimension over long periods of time.

Flexite M.P.-a thermoplastic acrylic, is a special blend of polymers and has the highest impact rating of any acrylic. You can bounce a Flexite M.P. denture off the floor without cracking the base. Flexite M.P. has a surface hardness of 55-65, making it popular for bruxism appliances as well as dentures.[12]

THERMOPLASTIC NYLON

Nylon is a resin derived from diamine and dibasic acid monomers. From an engineering standpoint, nylon is a versatile material with a depth of characteristics making it suitable for a broad range of applications. Nylon exhibits high physical strength, heat resistance and chemical resistance. It can be easily modified to increase stiffness and wear resistance. Because of its excellent balance of strength, ductility and heat resistance, nylon is an outstanding candidate for metal replacement applications. However, in dentistry, because of its inherent flexibility, it is used primarily for flexible tissue born partial dentures. It does not have enough strength to use for occlusal rest seats, and won't maintain vertical dimension when used in direct occlusal forces. Thermoplastic nylon is injected at temperatures from 274 to 293 degrees Celsius and has a specific gravity of 1.14. Mold shrinkage amounts to 0.014 in/in. The tensile strength is 11000 psi and the flexural strength is 16000 psi. Nylon is a little more difficult to adjust and polish, but the resin can be semi-translucent and provides excellent esthetics for flexible tissue born partial dentures.[5,12-15]

APPLICATIONS FOR THERMOPLASTIC RESINS

Applications for thermoplastics resins originally involved flexible tooth born partial dentures. Currently dental applications include: preformed partial denture clasp, flexible tooth born partial denture framework, single cast partial dentures, temporary crowns and bridges, provisional crowns and bridges, occlusal appliances, implant abutments, orthodontic and sleep apnea appliances, many of which have been described previously. However, with the development of new elastomers and copolymer alloys, there are certain to be many new clinical applications for thermoplastic resins in dentistry.[2,16,17]

Valplast (Valplast Int. Corp.) is nearly unbreakable, is colored pink like the gums, can be built quite thin, and can form not only the denture base, but the clasps as well. Since the clasps are built to curl around the necks of the teeth, they are practically indistinguishable from the gums that normally surround the teeth.[3] (Fig. 1)

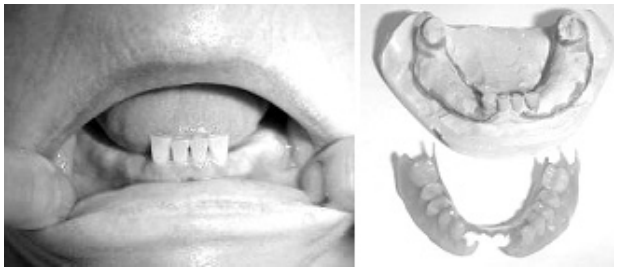

Figure 1. A lower Valplast partial denture.

Even though this denture does not rest on the natural teeth like the metal framework variety, the clasps rest on the gums surrounding the natural teeth. This tissue, unlike the gums over extraction sites, is stable and does not tend to change over time which keeps these RPD's stable and unchanging similar to the cast metal variety. The clasps can be seen (if you look hard) on the image on Fig. 2. just under the thumb and index fingers. This type of partial denture is extremely stable and retentive, and the elasticity of the flexible plastic clasps keeps them that way indefinitely.[18,19]

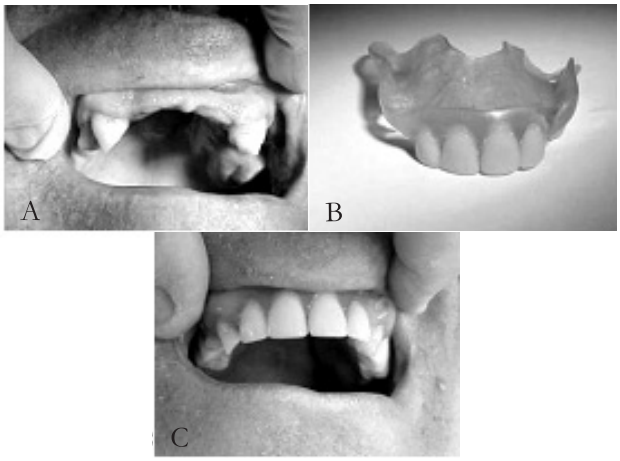

Figure 2. The flexible framework RPD's - Valplast: a) initial clinical status, b) the flexible RPD; c) the RPD in situ.

The Flexite Company has six different monomer free plastics for fabricating RPD's, dentures, TMJ's, bruxism, anti-snoring devices, sports mouth guards, tooth colored clasps, Flexite-metal combination cases etc. Flexite plastics are safe, non-toxic, comfortable, biologically inert, and meets the leaching requirements for colorants. Flexite plastics are esthetically superior to other plastics. Flexite plastics are CE certified. The Flexite Quality Assurance Program is designed to meet the ISO 9000 rules. [20,21]

Flexite Plus "flexible" partial dentures eliminate the use of metal, providing the patients with a partial denture alternative that delivers a precise fit, tissue-colored esthetics and maximum patient comfort. Flexite Plus, comparable to Flexiplast[14] and Valplast, is fabricated from a flexible thermoplastic material that is available in three tissue shades. The base component is nylon-polyamid. This kind is extremely elastic, almost unbreakable. The use of this material takes longer than the other ones.[5,22]

The material is monomer-free, virtually unbreakable, lightweight and impervious to oral fluids. Flexite Plus may also be combined with a metal framework to eliminate the display of metal labial clasps.[20] (Fig. 3)

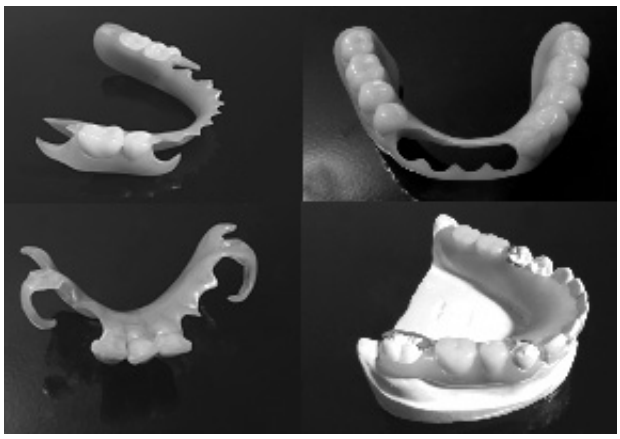

Figure 3. Flexite Plus flexible RPD's.

Flexite Supreme's base component: is a co-polyamid. This half-soft one has much wider range of use and dealing with this material makes denture manufacturing faster. High molecular flexite supreme is the ultimate cast thermoplastic for removable partials. The proportional limits (memory) is comparable to precious wire and yet it is flexible. Many dentists have switched from metal to Flexite Supreme because Flexite offers the patient superior comfort, esthetics and there is no metallic taste (Fig. 4). Flexite Supreme is easy to polish and adjust in house. It can be added to or relined in office or laboratory, with acrylic, when a bonding agent is applied to a non-flexing area! Cyano Acrylate is the coupling agent that chemically bonds acrylic to Flexite Supreme [20].

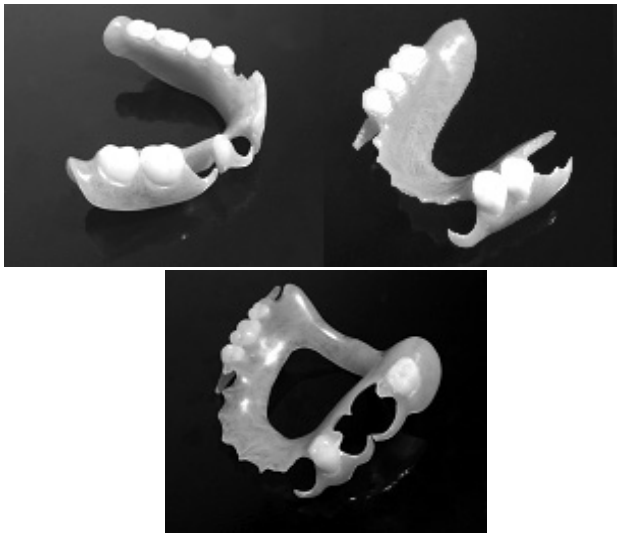

Figure 4. Flexite Supreme flexible RPD's.

Flexite MP contains fully polimerized acrylate, its base component is methyl-metacrylate. This material was developed for making full dentures, it doesn't behave elastic, but being a bit elastic, it is practically unbreakable. It can be polished easily.[20]

Northerm's base component: styrene acrylonitrate copolymer. Containing no acrylate, this material is for allergic patients. It can be combined with metals.

The flexible framework RPD can replace any number of teeth in a dental arch, similar to the flipper and cast metal RPD. There is, however, one type of removable tooth replacement device that can (legally) be built only out of the flexible framework variety of material. This is the single tooth RPD that we refer to as a NESBIT.[3] (Fig. 5)

Figure 5. The single tooth RPD - NESBIT.

CONCLUSION

Thermoplastic resins have been used in dentistry for over 50 years. During that time the applications have continued to grow, and the interest in these materials of both the profession and the public has increased. The materials have superior properties and characteristics and provide excellent esthetic and biocompatible treatment options. With the development of new properties, elastomers and copolymer alloys, there are certain to be additional new applications for thermoplastic resins in the future, to help patients with damaged or missing teeth.

REFERENCES

1. Caesar HH, Lehmann KM. Die Teilprothese – Grundlagen, Konstruktion und zahntechnische Ausführung, 3. überarbeitete Auflage, Verlag Neuer Merkur GmbH, München, 2002.
2. Wostmann B, Budtz-Jorgensen E, Jepson N, et al. Indications for removable partial dentures: a literature review. Int J Prosthodont 2005;18(2):139-45.
3. Negruţiu M, Sinescu C, Sandu Liliana, et al. Guidelines of removable partial dentures, Ed. Marineasa, Timişoara, 2004.
4. Lowe LG. Flexible denture flanges for patients exhibiting undercut tuberosities and reduced width of the buccal vestibule: a clinical report. J Prosthet Dent 2004; 92(2):128-31.
5. Phoenix RD, Mansueto MA, Ackerman NA, et al. Evaluation of mechanical and thermal properties of commonly used denture base resins. J Prosthodont 2004;13(1):17-27.
6. Beaumont AJ Jr. An overview of esthetics with removable partial dentures. Quintessence Int 2002;33(10):747-55.
7. Donovan TE, Cho GC. Esthetic considerations with removable partial dentures. J Calif Dent Assoc 2003;31(7):551-7.
8. Negruţiu M, Bratu D, Romînu M, et al. Polimeri utilizaţi în tehnologia protezelor mobile şi mobilizabile. Revista Natională de Stomatologie 2001; IV(1):30-41.
9. John J, Gangadhar SA, Shah I. Flexural strength of heat-polymerized polymethyl methacrylate denture resin reinforced with glass, aramid or nylon fibers. J Prosthet Dent 2001;86(4):424-7.
10. Fujisawa M, Adachi K, Tsuruta S, et al. A procedure for fitting a fixed partial denture to an existing removable partial denture. J Prosthet Dent 2004;91(4):392-4.
11. Heath JR, Boru TK, Grant AA. The stability of temporary prosthetic base materials. J Oral Rehabil 1993;20(4):363-72.
12. Janda R. Prothesenkunststoffe aus werkstoffkundlicher Sicht. Quintessenz Zahntech 1997;23(5):665-72.
13. Negruţiu M, Romînu M, Floriţa Z, et al. Influenţa tehnologiei de prelucrare asupra calităţii polimerilor pentru proteze mobile şi mobilizabile. Revista de Stomatologie 2001;V(1/2):107-12.
14. Parvizi A, Lindquist T, Schneider R, et al. Comparison of the dimensional accuracy of injection-molded denture base materials to that of conventional pressure-pack acrylic resin. J Prosthodont 2004;13(2):83-9.
15. Keenan PL, Radford DR, Clark RK. Dimensional change in complete dentures fabricated by injection molding and microwave processing. J Prosthet Dent 2003;89(1):37-44.
16. Hohmann A., Hielscher W. Lehrbuch der Zahntechnik, Band 1– Grundlagen, partielle Prothesen, Kronen– und Brückentechnik, Fünfte Auflage, Quintessenz Verlags–GmbH, Berlin, 1999.
17. Hohmann A., Hielscher W. Lehrbuch der Zahntechnik, vol.II, ed.4, Quintessenz-Verlags GmbH, Berlin, 2001
18. Pardo-Mindan S, Ruiz-Villandiego JC. A flexible lingual clasp as an esthetic alternative: a clinical report. J Prosthet Dent 1993;69:245-46.
19. Hiromori K, Fugii K, Inoue K. Viscoelastic properties of denture base resins obtained by underwater test. J Oral Rehabil 2000;27(6):522-31.
21. Mirada X. Le Flexite, une alternative au matériau résine. Proth.Dent 1999;20:153-4.
20. Lai YL, Lui HF, Lee SY. In vitro color stability, stain resistance, and water sorption of four removable gingival flange materials. J Prosthet Dent 2003;90(3):293-300.
22. Axinn S, O'Connor RP Jr, Kopp EN. Immediate removable partial denture frameworks. J Am Dent Assoc 1977;95:583-5.