

Polyamides As A Denture Base Material – A Review

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Abstract: *The dentists today have to meet growing demands for prosthetic rehabilitation due to population aging and higher requirements on the quality of life. That means higher demands on the functional reliability of dental appliances, their aesthetical and biological properties. Several studies have evaluated various properties of polyamide (nylon) denture base materials. According to the results of the studies, currently, thermo-injectable, high impact, flexible or semi-flexible polyamide is thought to be an alternative to the conventional acrylic resins due to its esthetic and functional characteristics and physicochemical qualities. Although polyamide has some attractive advantages, they require modifications to produce consistently better properties than the current polymethyl methacrylate (PMMA) materials. The purpose of this article was to review the biocompatibility, physical, and mechanical properties of the polyamide denture base materials.*

Keywords: *Polyamides, Nylon, Denture base material, Mechanical properties*

I. Introduction

Polymethyl methacrylate (PMMA) has been the most popular material used for denture fabrication since its introduction in 1937. It has several advantages such as an excellent esthetic characteristic, low water sorption and solubility, adequate strength, low toxicity, easy repair, and a simple molding processing technique. Nonetheless, it has some problems such as polymerization shrinkage, weak flexural, lower impact strength, and low fatigue resistance.^{1,4}

Although clinician's skills and experience play a major role in designing and fabricating an optimum prosthodontic restoration, the selection of denture resins is equally important, especially when the patient has to use the prostheses for long period of time.³ Nylon polyamides were first introduced in the construction of denture bases in 1950s.⁵

Nylon is a generic name for certain types of thermoplastic polymers belonging to the class known as polyamides. These polyamides are produced by the condensation reactions between a diamine $\text{NH}_2\text{-(CH}_2\text{)}_6\text{-NH}_2$ and a dibasic acid, $\text{CO}_2\text{H-(CH}_2\text{)}_4\text{-COOH}$.⁶⁻¹¹ Nylon is a crystalline polymer, whereas PMMA is amorphous. This crystalline effect accounts for the lack of solubility of nylon in solvents, as well as high heat resistance and high strength coupled with ductility.¹²

Moreover, it was claimed that nylon materials have other advantages including higher elasticity than common heat polymerizing resins, toxicological safety for patients with resin monomer and metal allergy, use of heat-molding instead of chemical polymerization to control the polymerization shrinkage and its related deformation.¹³ On the other side, it is reported that this material has several problems such as water sorption, surface roughness, bacterial contamination, warpage, color deterioration, and difficulty in polishing.¹⁴ The present literature review to appraise some physical, mechanical and clinical properties of nylon/ polyamide denture base materials.

Significant Properties

Physical Properties of the Nylons

Nylon is a crystalline polymer whereas polymethyl methacrylate is amorphous. Thus in solid nylon there is more or less ordered parallel packing of the long chain molecule which is due to strong attractive forces between the chains. This crystallinity account for the nylon characteristics of lack of solubility in solvents, high heat resistance, and high strength coupled with ductility.

The outstanding features of the nylons are their toughness, low density, abrasion resistance, higher melting point and resistance to chemical attack. Since nylon is insoluble in almost all common solvents it cannot be dough moulded by usual dental techniques, but molten material must be injected into the flask under pressure. The high mould shrinkage is a serious issue. The flexibility coupled with its strength, enables it to resist all normal attempts to fracture. Previous workers have criticized the flexibility of nylon on the basis that this flexibility can lead to uneven loading of the supporting mucosa and bone particularly in the mandible.¹⁵

Mechanical Properties of the Nylon

The chief advantage of nylon lies in exceptional mechanical properties of resistance to shock and repeated stressing, it has higher fatigue resistance compared to PMMA. Nylon has higher fatigue resistance than

polymethyl methacrylate, although no comparative data under mouth conditions are yet available.⁵ Though nylon has superior mechanical properties than any other non metallic base yet there are some serious limitations such as processing difficulties and dimensional changes.^{16,17} The chief advantages of nylon denture bases are strength and lightness. The chief advantages of nylon denture bases are strength and lightness. The ultimate tensile strength of nylon AI00/M is 10,000-11,500lb./sq. in. as compared with 7,000-8,000 lb./sq. in. for acrylic. This makes skeleton denture designs, which would be impracticable if made in acrylic, a feasible proposition when made with nylon.

Thermal Properties, Bacterial Growth, Staining

Nylon has low coefficient of linear expansion and galvanic conductance. According to Abuzar et al polyamide denture base material when polished with conventional laboratory technique became smoother than PMMA when using the same polishing technique. However the surface roughness of polyamide was well within the accepted norm and was clinically acceptably smooth after conventional polishing by lathe.¹⁸ It seems likely that at least part of the surface roughness may be due to growth of bacterial plaques on the surface of the nylon. In few cases smear layer were made from surface scrapings of the nylon denture bases and of the acrylic teeth on the bases which resulted in clinically noticeable staining.^{19,20}

The highest *Candida* species biofilm growth was shown to occur on polyamide resin when compared with PMMA.¹⁹ Although flexible resins present advantages in terms of esthetics and comfort, studies assessing chromatic and micro hardness alterations of these materials are still scarce in the related literature.²¹

Flexibility

Flexibility is a property, possessed by nylon, which is not usually considered to be advantageous in denture base materials. It can, however, prove to be a useful property in certain types of partial dentures while being unsuitable for other types.

The flexibility of nylon varies greatly depending on the type of moulding powder used, temperature of injection, pressure of injection surplus nylon remaining in the cylinder after injection was found to be brittle. This was attributed to the fact that it had not been under pressure when it set. More recent grades of nylon with low water absorption have proved to be more flexible. It may be worth mentioning that full dentures made of nylon are not flexible since they are usually too thick to display this property.²² Flexibility can be advantageous in conditions when the buccal undercut on the maxillary tuberosity are present together with reduced width of the buccal vestibule.²¹ Patient with systemic sclerosis and those who suffers from scarring in the oral and facial areas due to disease, trauma, or burning injuries, it is determined that long-term comfort and function could be achieved only through the use of a flexible removable partial denture.²² Nylon is also an effective method for correcting gingival recession by fabricating a flexible gingival epithesis. However, discoloration of the epithesis still remains a problem.

Dimensional Changes

Nylon is hygroscopic, its moisture content varies slowly with the surrounding conditions. On immersion in water the material swells, i.e. there is linear expansion.⁵ processing the denture base materials produced unequal deformation in different dimensions (anterior-posterior and cross-arch). The magnitude of this dimensional change depends on the conditions of moulding, shape of the mould, and direction in which it is measured.¹⁷

Cytotoxic evaluation of polyamide

There are several studies in regard to cytotoxicity of denture base materials.²³⁻²⁶ It has been reported that the acrylic resins used for the fabrication of denture bases have displayed various degrees of in vitro cytotoxicity and in vivo allergic responses, which have been probably caused by non-reacting components that remain after the polymerization process.²⁷ Nevertheless, studies about cytotoxic effect of polyamides are very limited. Uzun *et al*²⁸ investigated the long-term cytotoxic response of an injection-molded polyamide (Deflex) and heat- and cold-cured PMMA resins. According to the results of their study, all materials had a similar toxic effect in the short term and all tested materials reached the highest levels of toxicity after 8 weeks of their aging time. In their study, polyamide specimens had a comparable toxicity profile with the conventional PMMA denture base materials.

II. Conclusion

Physical and clinical properties of polyamides were briefly discussed in this review article. Although the flexural strength and modulus of elasticity and rigidity of nylon (polyamide) denture base materials are relatively low, they demonstrate great impact strength, toughness, and resistance to fracture. It was suggested that by adding glass fibers to polyamides, their stiffness and other mechanical properties could be increased. The

use of these materials for non-metal clasp dentures has some advantages regarding their esthetic and degree of retention. However, these materials show some degree of color instability in different beverages. Dental research teams and industry are looking for new materials with properties very similar to natural oral tissues, requiring simple handling. The new materials involve new technologies and devices which are being introduced into practical dental work from cosmic and other hi-tech projects.

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