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Review Article

SNEAK PEEK INTO PEEK POLYMER: AN INNOVATION

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ABSTRACT

New researches and technologies in Prosthetic dentistry are at its apex, specially utilizing the state of the art CAD-CAM manufacturing. Material Researchers are continuously testing innovative materials to match the technological advancements and ever increasing patient desires to look natural. Material that has unmatched strength, superior biocompatibility, low plaque affinity, aesthetics and characteristics close to the dental structure are desired. Polyether Ether Ketone (PEEK) meets all the demands and has proven its versatility in a very short span of time in recent prosthetic advancements. This article reviews one of the new dental material PEEK, its characteristics and uses in prosthodontics.

INTRODUCTION

Polyetheretherketone (PEEK) is a sulfonated aromatic high- temperature thermoplastic material. It belongs to the family of polyaryletherketone and are produced in three viscosity grades (high, medium and low) based on the same basic formula (-C6 H4 -OC6 H4 -O-C6 H4 -CO-) n. The aromatic chain of ring structure gives PEEK very high mechanical strength, it is highly inert, hence very resistive to chemical erosion. PEEK exhibits bone like flexibility and withstands high temperature1. It can be sterilized by radiation and heat without structural damage [2-5]. Overcoming the limitations of conventional materials like Cobalt chromium (CoCr) and titanium alloys, PEEK is widely accepted as an attractive biomaterial and as an excellent substitute of bone. The versatility of PEEK in the medical field includes artificial cranial plates, components of finger and knee joints, and intervertebral bodies (spine implants). It has been used in the field of orthopaedic surgery for almost four decades3. PEEK has made strong inroads in the field of Prosthetic dentistry. Apart from physiological properties, its esthetic properties such as proximity to natural teeth colour, radiolucency, rigidness and light weightness makes it the perfect choice for dental restorations. PEEK is used widely in CAD –CAM manufacturing for dental implants, provisional abutments, implant-supported bars, clamps for removable prostheses, and fixed dental prosthesis. Additionally it is also non-allergic and has low plaque affinity[6, 8, 9].

PROPERTIES OF PEEK

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· Thermal stability up to 335.8° C [7] .

· Tensile Strength (σt) is 90-100 MPa

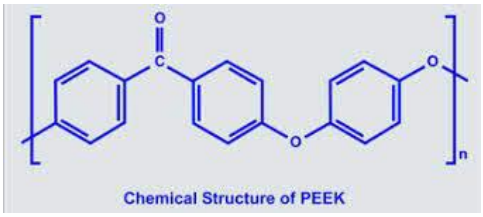

Figure 1: Chemical Structure of PEEK

· Density 1320 kg/m^3

· Thermal conductivity 0.25 W/m K [6, 9, 12] .

· PEEK's mechanical properties do not change during sterilization process, using steam, gamma and ethylene oxide [10, 11].

· Young's modulus is (E) 3.6 GPa 12, 13. Young's modulus and tensile properties are close to human bone, enamel and dentin [14].

· Water absorption, 24 hours (ASTM D 570) 0.1% Polyether ether ketone is resistant to hydrolysis, non-toxic and has one of the best biocompatibility [15, 16].

PEEK AS IMPLANTS

PEEK was introduced to dental applications in 1992, first in the form of esthetic abutments and later as implants[15]. After this it has been successfully used as a material in a number of applications including dental implants, healing caps, temporary abutments (due to its mechanical strength, aesthetic qualities, soft tissue response and its ability to shape easily), implant-supported prosthesis[5, 17-21]. The iso elasticity of PEEK composites ensures that they warp identically to bone and thus produce a more homogenous distribution of stress along the implant bone interface. They have shown good strength, fracture resistance and satisfactory bio inertness.

PEEK AS FIXED PROSTHESIS

PEEK dental three unit fixed prosthesis showed excellent performance during in – vitro investigation. No damage occurred to the frameworks or decementations were observed during the prolonged chewing simulation time used to simulate oral stress

Figure 2 : Spinal Implants of PEEK

Figure 3: FPD of PEEK

conditions equivalent to 5 years intraoral use. PEEK restorations have greatly exceed the fracture resistance required to withstand masticatory forces assumed for anterior (300N) and posterior regions (500-600N) [22]. Therefore PEEK substructures could be used in clinical applications. Dental PEEK is reinforced by carbon or glass fibres in different percentages and sizes, according to information provided by the manufacturers and it can influence its milling process [2, 23-25].

PEEK AS REMOVABLE PARTIAL DENTURE

The mechanical and physical properties of recently developed polymers, such as the aryl-ketone polymers, are similar to those of bone and dentin[6]. This can allow for the production of RPDs that are less intrusive while remaining stable and comfortable. In addition, many of these polymers are heat resistant and can offer autoclave disinfection of the prostheses. This material can be used for patients allergic to metals, or who dislike the metallic taste, the weight, and the unpleasant metal display of the denture framework and retentive clasps. The modified PEEK material, known

as BioHPP, is a biocompatible, non-allergic, rigid material with flexibility comparable to bone, high

Figure 4: RPD of PEEK

and low absorption properties, low plaque affinity, and good wear resistance.

PEEK AS MAXILLOFACIAL PROSTHESIS

Reports of the use of PEEK in the reconstruction of maxillofacial defects have been limited[26].Extensive maxillofacial defects resulting from trauma or oncologic resection present reconstructive challenges. Various auto grafts and alloplastic materials in conjunction with standard soft-tissue techniques have been used in the reconstruction of these types of defects. Polyetheretherketone (PEEK) is a semi crystalline polyaromatic linear polymer exhibiting an excellent combination of strength, stiffness, durability, and environmental resistance. Patients had excellent postoperative aesthetic and functional results without complications such as infections or extrusions. Because PEEK implants are customizable, easily workable, inert, and nonporous, they represent an ideal alloplastic material for maxillofacial reconstruction.

CONCLUSION

In a relatively short span of time, peek became the material of choice for metal free restorations in medical as well as dental applications. It copes well with ever increasing performance demand of precision fitting, natural feeling, flexibility, durability, robustness, ease of use and esthetics. It does not gets affected by the milling process of latest cad-cam technologies. Uses of peek in dental technology includes abutments, fixed prosthetic frameworks and removable partial denture frameworks including

Figure 5: Implants of PEEK

precision attachments. More researches should be done regarding the versatility of peek.

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