

Polyether Ether Ketone: A Superior Substitute to Prosthetic and Implant Materials

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Abstract: Polyether ether ketone is a multifaceted polymeric material that has extensive applications in dentistry including tooth restorations, crowns, bridges, endposts, denture framework, implant supported final prosthesis, dental implants⁶. The availment of the PEEK in developing a prosthesis for maxillectomy in patients diagnosed with mucormycosis and its adoption as an important material is being discussed here. The ease to mould the material according to our desirable characteristics and its greater properties compared to other existing materials are the reasons for its quickly emerging nature in dentistry.

Keywords: Polyether ether ketone, PEEK prosthesis, PEEK implants, properties of PEEK, better alternative to existing materials

1. Introduction

PEEK material is a polycyclic, aromatic, thermoplastic polymer. It can be processed by injection moulding, extrusion, compression moulding and powder coating.

Mucormycosis is one of the prevalent fungal infections world-wide during the COVID pandemic. The prevalence of infection is estimated to be 140 per million population in India. Of all the black fungus cases reported in India, 77% cases were rhinocerebral in nature¹. Maxillectomy is the ultimate treatment in severely immunocompromised patient diagnosed with this fungal infection affecting the sinuses. Such patients are provided with the obturator prosthesis after the procedure that is usually made of silicones (commonly used material).

PEEK will be a better replacement material for obturator prosthesis due to following reasons²:

- The tensile strength of PEEK (90 - 100 MPa) is higher than that of silicones (4 - 12.5 MPa) which will resist tearing of the material due to tension.
- The glass transition temperature of PEEK (143C) is more than that of silicone (125C) that will reduce the chances of brittleness of the obturator at higher temperature while processing (350C - 400C).
- The specific heat of PEEK (1340 J/g/C) is also high when compared to silicone (1050 J/g/C) that will allow absorption of heat without significantly changing the temperature of the material.
- Electrical resistivity of PEEK is more that makes it to possess less ability to conduct electric current.
- Density (1.26 g/cm) of PEEK is less compared to silicones (2.3 g/cm) that will impact light weight to the material making it easy and comfortable to the patient.
- Thermal diffusivity of PEEK is less than silicones making it resistant to heat or cold quickly according to surrounding temperature.
- Thermal shock resistance of PEEK is more than that allows it to withstand sudden changes in temperature either during heating or cooling.

Titanium is the most familiar and frequently used material for implants worldwide. However, hazards caused by the material and implant failure are of major concern now.

- Titanium causes occasional metal hypersensitivity. Sensitivity to titanium is characterized by the local presence of abundant macrophages and T lymphocytes and the absence of B lymphocytes indicating hypersensitivity. Being a non - metal, PEEK doesn't show metallic hypersensitivity³.
- Contamination is seen related to peri-implantitis. Bacteria produce acidic toxins and acidifies the surrounding environment. This can cause disruption or dissolution of titanium oxide layer, leading to loss of passivating layer, finally causing corrosion. There is a minimal damage by PEEK in such conditions when compared to titanium³.
- Titanium causes scattered radiation that may cause problems from prolonged healing to osteoradionecrosis. But the X - ray transparency of PEEK allows the fusion to be readily visualized and because it is not metallic, it is compatible with both CT and MRI⁴.
- Titanium causes Yellow Nail Syndrome, 150 reported cases are present. Berglund hypothesized that titanium ions are released due to galvanic interaction that may lead to yellow discoloration⁸.
- Titanium has higher elastic modulus (110 GPa) when compared to cortical bone (15 GPa). Due to this difference, it may cause stress in the implant - bone interface during load transfer resulting in peri - implant bone loss (stress shielding). PEEK has elastic modulus (3.6 GPa), by incorporating carbon fibers, elastic modulus can be improved to 18 GPa – close to cortical bone, hence lesser shielding stress⁵.

Other properties of PEEK:

- It does not attrite opposing natural teeth.
- Bio HPP, modified form of PEEK is advantageous for being anti allergic in nature, non - metallic in taste, excellent polishing properties, low plaque affinity and good wear resistance. It possesses high fracture resistance.
- Addition of fillers, reduction of contact angle – hydrophilic character can be acquired.

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- Sarot et al. compared the stress distribution of 30% carbon fiber reinforced PEEK and titanium using a finite element method. The findings could lead to the assumption that an endless carbon fiber dental implant could show decreased stress peaks at the bone - implant interface due to decreased elastic deformation⁹.
- Xu et al. developed CFR - PEEK nanohydroxyapatite with micro/nano topographical structures by modifying them with oxygen plasma and sandblasting the surface to obtain potential bioactive material for bone grafting with enhanced biocompatibility and osseointegration¹⁰.

2. Conclusion

Even though PEEK material was invented in 1900s, its use has been limited to medical cases and few of the dental cases. Certain modifications⁷ by incorporating glass or carbon fibers to conventional PEEK will lead to the development of a superior property compound that can later be employed in most of dental cases with minimal adverse effects.

3. Future Scope

Polyether ether ketone will emerge as one of the best materials with impeccable properties that are desirable for prosthesis or implant or any other dental equipment that will be more acceptable by the patients. The only drawback of the material is its cost which is not so easily affordable but its use in daily practice will make it exceptional.

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Author Profile



V Sahithi, final year BDS student from Kamineni Institute of Dental Sciences, Narketpally, Telangana. She is very fascinated about doing research and have been citing through many articles. This is her first article and she assume that this material would definitely come into daily practice for ease of our dentists and would be an extra ordinary material in dental material sciences.