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EVALUATION OF PEEK NANO COMPOSITE PROPERTIES FOR DENTAL APPLICATIONS

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ABSTRACT
Polyether ether ketone (PEEK) and polyether ketone ketone (PEKK) are high-performance thermoplastic polymers widely used in dental applications due to their excellent mechanical properties and biocompatibility. However, their inherent hydrophobicity and limited bioactivity restrict their clinical performance. To overcome these limitations, nanofillers such as titanium dioxide (TiO_2) and hydroxyapatite (HA) have been incorporated to form PEEK nanocomposites.
In this study, PEEK nanocomposites were fabricated using a twin-screw extrusion process followed by compression molding under controlled temperature and pressure conditions. The addition of nanofillers significantly enhanced the mechanical properties, including elasticity and stiffness, while maintaining structural stability without degradation or wear.
Compared to conventional materials like titanium, PEEK nanocomposites exhibit improved biomechanical compatibility, reduced weight, and enhanced esthetics. These findings suggest that PEEK nanocomposites are promising materials for advanced dental applications, including implants, prosthodontic frameworks, and orthodontic devices.
KEYWORDS: PEEK, PEKK, Nanocomposite, Dental biomaterials, Hydroxyapatite, Titanium dioxide, Dental implants, Prosthodontics, Orthodontics

INTRODUCTION
Polyether ether ketone (PEEK) and polyether ketone ketone (PEKK) are high-performance thermoplastic polymers that have gained considerable attention in dentistry due to their favorable mechanical, chemical, and biological properties [1]. These materials are chemically inert, highly resistant to wear, and possess excellent biocompatibility, making them suitable for various dental applications such as implants, prosthodontic appliances, and orthodontic devices [2].
Despite these advantages, conventional PEEK is highly hydrophobic and exhibits limited bioactivity, which may compromise its integration with biological tissues [3]. To enhance its properties, nanotechnology has been employed by incorporating nanofillers such as titanium dioxide (TiO_2) and hydroxyapatite (HA). These nanofillers improve mechanical strength, surface characteristics, and biological activity, resulting in the formation of PEEK nanocomposites [4].
PEKK, a variant of PEEK, demonstrates superior elasticity and increased biomechanical stiffness, along with minimal degradation and wear [5]. However, it is typically used as a base material, and its properties can be significantly enhanced through reinforcement with nanofillers.
The use of PEEK in dentistry is often compared with titanium, a widely used conventional material. Unlike titanium, PEEK exhibits an elastic modulus closer to that of bone, reducing

stress shielding and improving load distribution [6]. Additionally, PEEK offers advantages such as lightweight structure, radiolucency, and improved esthetics.
Therefore, the development of PEEK nanocomposites represents a significant advancement in dental biomaterials, aiming to combine superior mechanical properties with enhanced biological performance.

AIM

To evaluate the properties of PEEK nanocomposites for their application in dental materials.

OBJECTIVES

- To fabricate PEEK nanocomposites using extrusion and compression molding techniques
- To incorporate nanofillers such as titanium dioxide and hydroxyapatite
- To evaluate the mechanical properties including elasticity and stiffness
- To assess the stability and durability of the nanocomposite material
- To compare the performance of PEEK nanocomposites with conventional materials like titanium
- To determine their suitability for dental applications

Materials and methods

- PEKK composites were fabricated by twin screw extruder followed by compression moulding.
- The composition of Nano composite of PEKK are given in the table 1
- All the ingredients (polymers and nano fillers) were extreded and compression moulded at a temperature of 380degrees celsius and pressure of 2 mpa.
- After processing of four hours, the composite was taken out.

RESULTS AND DISCUSSION

The fabricated PEEK nanocomposites showed improved mechanical and structural properties compared to unmodified PEEK.
Mechanical Properties
The incorporation of nanofillers resulted in:

- Increased elasticity
- Enhanced stiffness
- Improved resistance to deformation

These findings are consistent with previous studies that reported improved mechanical performance of reinforced PEEK materials [3,4].
Material Stability
The processed composites demonstrated:

- No observable material degradation
- Minimal wear characteristics
- High structural integrity

This indicates that PEEK nanocomposites are suitable for long-term dental applications [5].
Effect of Nanofillers
Hydroxyapatite contributed to:

- Increased bioactivity
- Improved bone compatibility

Titanium dioxide enhanced:

- Mechanical strength
- Surface properties

The synergistic effect of these fillers improves the overall performance of the material [4].

Comparison with Titanium

Compared to titanium, PEEK nanocomposites offer:

1. Lower weight
2. Better shock absorption
3. Elastic modulus closer to bone
4. Improved esthetic appearance

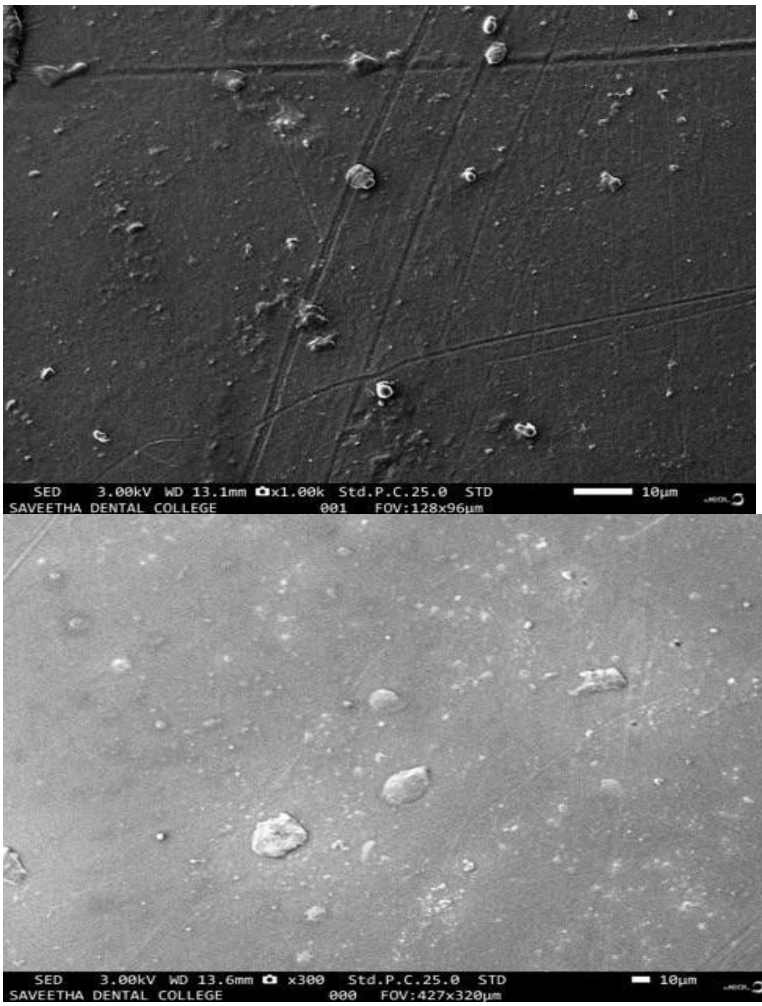
These characteristics reduce stress shielding and enhance patient comfort [6].

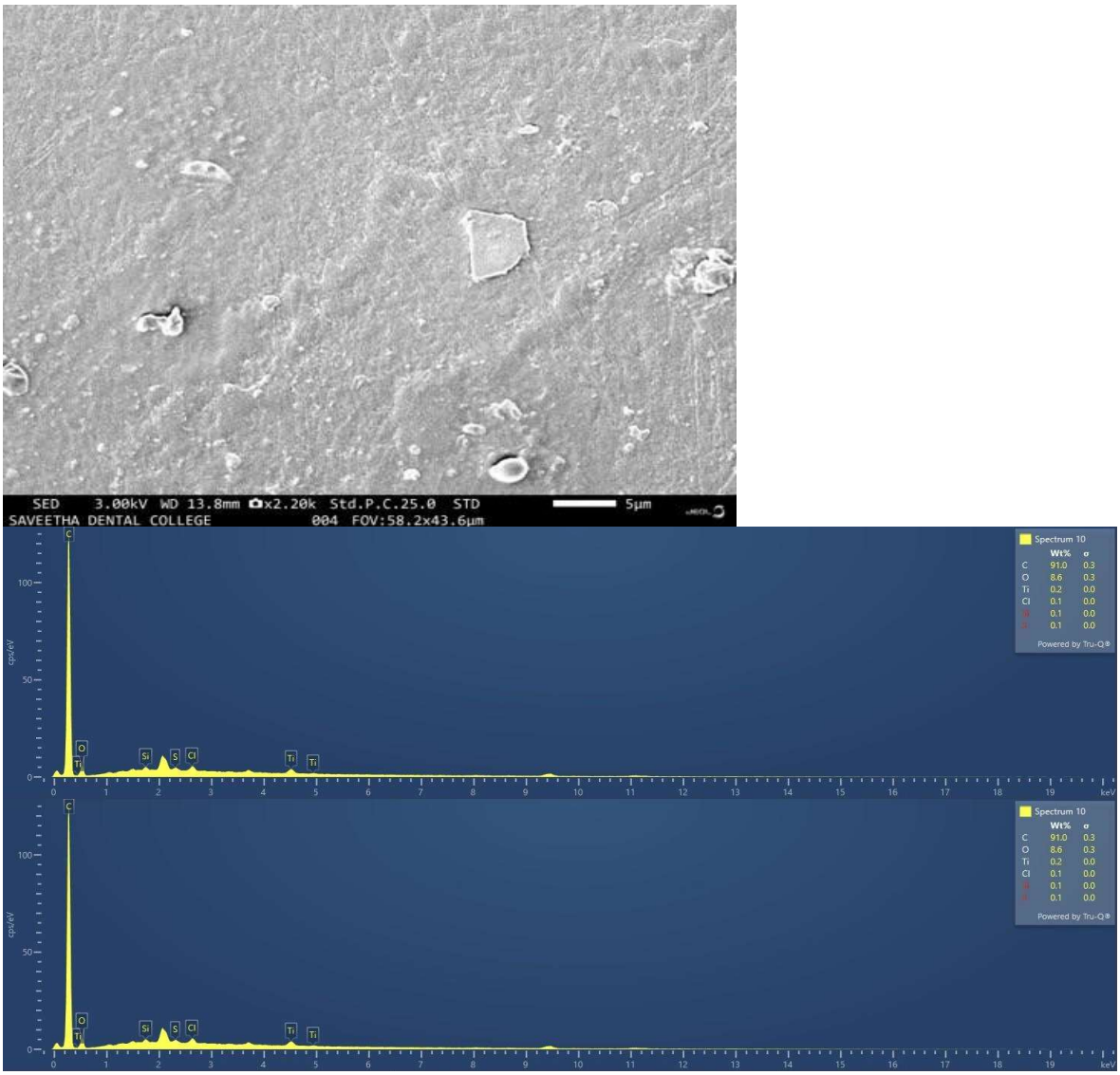
Clinical Implications

PEEK nanocomposites can be effectively used in:

- Dental implants
- Fixed and removable prostheses
- Orthodontic appliances

Thus, the material demonstrates strong potential as an alternative to conventional metallic biomaterials.





CONCLUSION

PEEK nanocomposites exhibit enhanced mechanical properties, improved stability, and increased bioactivity compared to conventional PEEK. The incorporation of nanofillers such as titanium dioxide and hydroxyapatite significantly improves the performance of the material, making it suitable for dental applications.

Compared to traditional materials like titanium, PEEK nanocomposites provide better biomechanical compatibility, reduced weight, and improved esthetics. These advantages make them a promising material for future dental applications. Further research is required to evaluate long-term clinical performance and optimize material composition.

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