Annals of Materials Science & Engineering

Open Access

Austin Publishing Group

Editorial

Research Progress of Polyether ether ketone Biocomposites

Kang Gan, Hong Liu*, Xiuju Liu and Deli Niu
College and Hospital of Stomatology, Jilin University, PR China

***Corresponding author:** Hong Liu, College and Hospital of Stomatology, Jilin University, 1500 Qing Hua Road, Changchun 130021, PR China

Received: April 24, 2015; **Accepted:** May 05, 2015; **Published:** May 07, 2015

Introduction

Polyether ether ketone (PEEK) is a semi crystalline thermoplastic polymer, which exhibits good mechanical properties and excellent resistance to high temperature, chemicals, and radiation. This biomaterial has been widely applied in aerospace, automobile manufacturing, precision instrument manufacturing industries, and other high-technology fields [1-2]. PEEK also displays good biological characteristics, such as biological safety, ideal elastic modulus, potential antibacterial activity, and transparency to X-rays. PEEK has been considered as a medical biological material used in human implantation and approved by the FDA [3]. Along with the rapid progress of nano-modification technology, key technologies to synthesize and prepare composites have been developed; studies on PEEK biocomposites have also shown great progress. In order to expand application of PEEK-based composites in medical field, the characteristics of PEEK must be tailored by incorporating with different fiber or nanoparticles. Furthermore, novel PEEK-based biocomposites with superior performance have been fabricated. This paper briefly reviews the related research progress about PEEK-based composites used as biocomposites and outlook its application prospect in joint arthroplasty, prosthodontics, spinal cages, dental implantology, bone defect repair and other medical applications.

Fiber-reinforced PEEK biocomposites

Fiber is a flexible linear material with a diameter ranging from a few microns to a few tens of micrometers; this material plays an important role in the preparation of PEEK composites. Several kinds of fibers can be melt-blended with PEEK. For instance, concentrated carbon and glass fibers are incorporated in PEEK to prepare biomaterials.

Carbon and glass fibers are inorganic polymer materials with high strength, high modulus, and high temperature resistance. As such, many advantages are provided by composites incorporated with these fibers. For example, new composites with high mechanical strength and low elastic modulus can be obtained by adjusting fiber content. Moreover, the addition of a small amount of carbon and glass fibers in the PEEK matrix can significantly reduce wear coefficient and improve wear resistance. Carbon fiber reinforced PEEK (CFR/PEEK) and glass fiber reinforced PEEK (GFR/PEEK) composites exhibit excellent mechanical properties; therefore, these materials can be used in medical applications.CFR/PEEK and GFR/PEEK composites have also been used to fabricate artificial joints, screws, intervertebral fusion devices, and dental implants [4-7].

Active particle-reinforced PEEK biocomposites

Although PEEK shows outstanding mechanical and biologically safe properties, biological inertness of this material severely limits applications in the field of orthopedic implants. To improve biological activity and expand the range of application in medicine, researchers developed bioactive composites by incorporating active particles.

Hydroxyapatite (HA) is a relatively common active particle because this material is characterized with a crystal structure; the corresponding phosphorus ratio is almost similar to that of bone tissue, which elicits significant biological activity. Therefore, HA is commonly incorporated in PEEK, and the biological activity of this material is evaluated in vitro and in vivo. With HA, the biological activity of PEEK is significantly improved [8-10]. Compared with HA, fluorapatite (FA) displays more stable physical and chemical properties, greater osteogenic activity, and antibacterial activity. FA/PEEK biocomposite also shows excellent antibacterial property and biological activity [11]. Nano-TiO_2 and nano-SiO_2 particles exhibit good biological activity and toughening effect. Nano-TiO_2/PEEK biocomposites with superior osteogenic activity have been prepared [12]. Furthermore, nano-SiO_2/PEEK biocomposites have been developed as prosthodontics and dental implants [13].

PEEK biocomposites with multiple reinforcements

The biological activity of PEEK can be improved by incorporating HA or FA in PEEK; however, the resulting composite is brittle, and mechanical properties are weakened. To resolve this drawback, researchers incorporated carbon fiber in HA/PEEK composites; thus, the biological activity and mechanical properties of PEEK are enhanced [14-15]. Furthermore, strontium yields a high modulus and promotes bone formation. Strontium-containing HA-reinforced PEEK has been synthesized. Sr/HA/PEEK composites with excellent mechanical properties and biological activity have also been prepared [16].

Looking forward

In recent years, there are many different modification methods which can be used for PEEK-based biocomposites. However, further research is still needed to clarify which method is more appropriate. At the same time, long-term clinical studies are also very necessary for medical implant materials. According to clinical trials and a large amount of basic research about PEEK and its composites, we will be able to fabricate many novel PEEK-based biocomposites with outstanding performance in the near future. Superior PEEK

Citation: Gan K, Liu H, Liu X and Niu D. Research Progress of Polyether ether ketone Biocomposites. Ann Materials Sci Eng. 2015;2(1): 1020.

biocomposites can be further developed on the basis of excellent properties of PEEK-based biomaterials and rapid advancements in CAD/CAM digital processing and 3D printing technology. These biomaterials can be used in bone defect repair, joint arthroplasty, prosthodontics, dental implantology, and other medical applications.

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Ann Materials Sci Eng - Volume 2 Issue 1 - 2015
ISSN : 2471-0245 | www.austinpublishinggroup.com

Citation: Gan K, Liu H, Liu X and Niu D. Research Progress of Polyether ether ketone Biocomposites. Ann Materials Sci Eng. 2015;2(1): 1020.