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論　文　内　容　要　旨

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| 学位論文題目 | Improvement of Mechanical Properties of Carbon/PEEK Composites for Bio-Materials (生体材料適用のための炭素繊維/PEEK複合材料の機械的特性の向上) | | |

内容要旨


The purpose of this study is to determine the correct estimation of the mechanical properties of carbon/PEEK composites and its validity has been tested with the alternative materials of the metal-based materials for artificial hip joint.

This study evaluated the mechanical properties according to the temperature of heat treatments for the sizing removal of carbon fiber and the fiber ply orientation.

First, the sizing removal of carbon fiber was conducted at 300℃ for 4 hours and 400℃ for 2 hours respectively. The fractured surface in the specimen of tensile test made from PEEK and epoxy resin was observed by SEM. The fracture surface of the tensile test specimen of the carbon/epoxy composites heat-treated to 400℃ showed that the resin did not adhere nearly in the fiber surface and pull out was observed. It is considered that 400℃ is suitable heat treatment temperature for the sizing removal of the carbon fiber. The mechanical test results represent that there was no significant differences in short beam strength. However, the tensile strength and compressive strength of the carbon/PEEK composites were higher than those of the carbon/epoxy composites in the case of the vacuum bag process. Furthermore, this result indicated that the sizing material did not have a significant effect on the strength of the carbon/PEEK composites.

Second, the specimens for the carbon/PEEK and carbon/epoxy composites were manufactured based on the ASTM standard. The specimens were immersed in distilled water at 37℃ for 100 days and the coefficient of moisture was measured in accordance with Fick's law. Moreover, the fracture energy according to the fiber ply orientation was evaluated in this study. The result exhibited that the coefficient of moisture-absorption of carbon/PEEK composites was the lowest because the interface coherence between the fiber and resin are the strongest. As a result, the fracture energy of the carbon/PEEK composites was superior to the carbon/epoxy composites.

Third, the effect of Carbon/PEEK composites on the tribological properties has been investigated. The unidirectional composites had higher friction coefficients than those multidirectional composites. This was caused by the debonding between the carbon fiber and the PEEK sheet, which was proportional to the contact area between the sliding surface and the carbon fiber. The friction test results showed that there was no significant differences in relation to the

fiber ply orientation. However, the friction properties of the carbon/PEEK composites were higher than those of the carbon/epoxy composites. As a result, it seemed that when the carbon/PEEK composites slid in a direction normal to the prepreg lay-up direction, its friction coefficient may be represented a smaller value compared to sliding in a direction parallel to the prepreg lay-up direction. In a case where the speed was 2.5 m/s, the friction coefficient was relatively large for configuration I. The friction surface of the specimen was analyzed using an electron microscope. In all cases, the debonding of the fiber and PEEK could be confirmed.

Finally, it is suggested that a new concept design of the stem and aims to determine the suitability of various carbon/PEEK composite should be designed for artificial hip joints. Shear stress and principal stress tested with alternative materials of the Ti-based stem for artificial hip joints. In addition, FEA is conducted according to the fiber ply orientation and the load condition for carbon/PEEK composites.

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論文審査の結果の要旨

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学位論文題目

Improvement of Mechanical Properties of Carbon/PEEK Composites for Bio-Materials

（生体材料適用のための炭素繊維/PEEK複合材料の機械的特性の向上）

審査結果の要旨

本研究は，生体に親和性がある PEEK を母相に炭素繊維を配向した複合材料 CFRPEEK の機械的及び摩耗特性の解析を扱ったものである。PEEK に炭素繊維を配合したプレプレグを幾層にも重ねて積層することによって新規な優れた機械的および摩耗特性を示す。

本研究では、PEEK と炭素繊維の複合材料を生体材料として適用することをと目的に機械的及び摩擦特性を明らかにしたものである。

まず、PEEK を母相に炭素繊維を配合したプレプレグを幾層にも重ねて積層することによって機械的特性、摩擦特性に優れた生体適合複合材料を作製することに成功した。この複合材料を股関節に適用するための設計モデルの作成に取り組み、実用化を目指したところに彼自身の創意と工夫が見られる.

以上本研究は，生体材料を適用のために CFRPEEK の機械的特性を扱った優れた論文であり，本論文は博士（工学）の学位授与に値するものと判定する.