

IMPARTATION OF APATITE FORMING ABILITY TO BIOINERT CARBON NANOTUBE-PEEK

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ABSTRACT

We aimed to impart apatite forming ability to carbon nanotube-PEEK composite with 10% carbon nanotube (CNT-PEEK). First of all, the CNT-PEEK was treated with sulfuric acid to form fine pores. Then, hydrophilicity of the sample was improved by O₂ plasma treatment. After that, the sample was promptly immersed in SBF which was adjusted at 25°C and pH 8.40 and held in an incubator at 70°C for 1 day to deposit fine particles of amorphous calcium phosphate (apatite nuclei). We confirmed that apatite nuclei were formed on the surface of the sample by SEM image and peaks of P and Ca by EDX profile. When the sample obtained in above three steps was immersed in SBF, it was covered with hydroxyapatite within 1 day by apatite nuclei which deposit in fine pores and high apatite forming ability was successfully imparted.

Keywords: PEEK, carbon nanotube, apatite forming ability, simulated body fluid

INTRODUCTION

Polyetheretherketone (PEEK) is an engineering plastic with great material property such as heat resistance, chemical resistance and radiation resistance and attracted attention as a biomaterial [1]. Because of its biocompatibility, the PEEK is expected to apply as an artificial bone material. In addition, carbon nanotube-PEEK composite with 10% carbon nanotube (CNT-PEEK) has electrical conductivity in addition to mechanical characteristics of PEEK.

However, the CNT-PEEK has a disadvantage of lack of bioactivity which is essential to artificial bone material. Therefore, we need to impart bioactivity by some surface treatment. If we achieve coating method of hydroxyapatite that is known for very high affinity with living organisms such as cells and proteins on the CNT-PEEK, we may be able to develop not only artificial bone but also high-performance small devices using cells as sensor elements such as biosensors and tip devices.

Simulated body fluid (SBF) [2-5] is an aqueous solution with an inorganic ion concentration almost equal to human blood plasma. When we raise the temperature and pH of SBF, particles of calcium phosphate, which we refer as 'apatite nuclei', precipitate by homogeneous nucleation [6,7]. In the previous study, we formed the apatite nuclei on the PEEK after sulfuric acid treatment and oxygen plasma treatment and we found that the apatite nuclei induced high activity to form hydroxyapatite in SBF and the surface of PEEK was covered with hydroxyapatite within 1 day [8-10].

In this study, we tried to impart bioactivity to CNT-PEEK with conductivity using the similar process. Apatite forming ability of the treated CNT-PEEK was evaluated in SBF.

METHODS

Impartation of Apatite Forming Ability

We processed in the following steps to impart apatite forming ability to the CNT-PEEK. The CNT-PEEK (TECAPEEK ELS nano black, Ensinger, Germany) with 10 mm in diameter and 2 mm thickness were used as samples. Both surfaces of samples were polished by using #400 and #1200 abrasive paper. Then the samples were washed ultrasonically in acetone, ethanol and pure water for 10 minutes and then air-dried. The samples were immersed in concentrated sulfuric acid at room temperature for 4 seconds in total and then washed with pure water. Furthermore the samples were washed ultrasonically in pure water