北海道大学 大学院工学研究院 材料科学部門主催

第 １２４ 回 マ テ リ ア ル セ ミ ナ ー

題目：Mechanical properties of polyoxymethylene/functionalized hydroxyapatite nanocomposites

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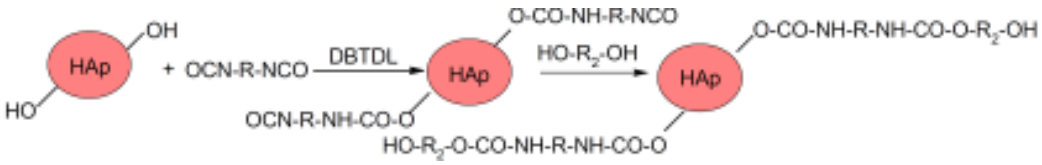
Abstract

Polyoxymethylene (POM) is a widely used engineering thermoplastic polymer devoted to technical and biomedical applications. However, POM is a bioinert polymer and to improve its biocompatibility it has been modified with hydroxyapatite (HAp) and functionalized HAp. HAp functionalization was performed using diisocyanates as coupling agents to graft polymer chains (poly(ethylene glycol) (PEG) or poly(ε-caprolactone) (PCL)) on the surface of HAp nanoparticles to obtain HAp-graft-PEG or HAp-graft-PCL – Scheme 1.



Scheme 1.
Functionalization of HAp nanoparticles with PEG or PCL using 1,6–hexamethylene diisocyanate as a coupling agent

Next, HAp and functionalized HAp have been incorporated to POM matrix using melt processing methods. The obtained nanocomposites were investigated as potential biomaterials for orthopedic applications.

The mechanical properties and durability are crucial issues in orthopedic applications. The influence of HAp and functionalized HAp on mechanical properties of polyoxymethylene nanocomposites was investigated using both conventional mechanical tests as well as nondestructive ultrasonic methods. It was observed that the mechanical properties strongly depend on the crystallinity of obtained nanocomposites. Moreover, kind of POM (homo- or copolymer), POM average molar mass, kind of grafted polymer and its average molar mass (chain length) influence Young modulus and other mechanical properties.

From nondestructive ultrasonic investigations it has been found the highest values of both longitudinal and transverse propagation waves and Young's/shear modulus were for POM homopolymer (DH) and POM copolymer T2H. This effect can be explained by higher degree of crystallinity of these materials in comparison to UH copolymer. Additionally, excellent POM nanocomposites durability and stability of mechanical properties even after 1000000 mechanical loading cycles were observed evidencing an enhancement of mechanical properties by HAp nanoparticles.