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Design and Simulation of a Biocompatible Prosthesis Ti-15Mo-XTa Alloy: An Analysis of Mechanical Integrity Using Finite Element Modeling

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Abstract

The main focus of this work is the development and simulation of a prosthesis using a high entropy alloy known as Ti-15Mo-XTa. The selection of this alloy is based on its compatibility with the human body, which is a crucial factor when choosing materials for medical implants. Traditional metal implants can cause several problems for patients, including toxic reactions from the release of metal ions, wear and tear of joint replacements from movement, and structural failure from repetitive loading. To address these concerns, the present study creates a three-dimensional finite element model of the prosthesis using COMSOL software. The model includes both isotropic and anisotropic materials and is subjected to various mechanical loads based on experimental studies. The finite element method is used to analyze the distribution of stress and strain across adjacent elements of the prosthesis. By simulating the behavior of the prosthesis under different loading conditions, valuable insights into its performance and durability can be gained. To assess the static design, the prosthesis is tested using COMSOL simulation software and subjected to loading conditions of 70, 90 and 110 kg. The objective of this assessment is to determine the robustness and ability of the design to withstand real-world mechanical demands. By conducting these simulations and tests, the researchers hope to contribute to the development of improved prostheses that can offer better functionality, longevity and overall patient satisfaction.

Keywords: prosthesis, high entropy alloys, titanium alloys, femurs, finite element analysis

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