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Improving Mechanical and Fatigue Characteristic of Trans-Tibial Prosthetic Socket

Kahtan Al-Khazraji
University of Technology
Materials Engineering Dept.
Iraq
dr_kahtanalkhazraji @yahoo.com

Jawad Kadhim
University of Technology
Materials Engineering Dept.
Iraq
jawadkad@yahoo.com

Payman Sahbah Ahmed
Koya University
Faculty of Engineering
Petroleum Dept.
payman_suhbat@yahoo.com

Abstract

In this study, five laminated composite materials used for manufacturing trans-tibial prosthetic sockets by using vacuum molding technique. The matrix materials of these composites is Blend of (50 wt. % Epoxy and 50 wt. % PMMA), reinforced with perlon layers, fiber glass layers, carbon fiber layers, hybrid (carbon and glass) fiber layers, and hybrid (carbon and glass) layers with micro Silica particles. The tensile properties, maximum shear stress, fracture toughness and alternating bending fatigue properties were measured experimentally. The theoretical part of this work deals with calculations of the fatigue ratio, theoretical factor of safety and failure index. The finite element technique (ANSYS-11) is used to analyze and evaluate alternating bending fatigue characteristics by observing the contours distribution of fatigue life, safety factor, equivalent Von Mises stress, total deformation and maximum shear stress. The results show that changing the type of reinforcement and matrix has a great influence on the measured properties: ultimate tensile strength of (Blend with Glass reinforcement) is the highest. The highest maximum shear stress, fracture toughness, fatigue limit, strain energy limit and safety factor is obtained in Blend with Glass composite with (59.42) MPa, (8.45) MPa.$m^{1/2}$, (62) MPa, (96.66) Joul/mm^3 and (9.3), respectively. Reinforcement with perlon gave the lowest values in all measured properties used in this study.