Mechanical, wear, and low cycle fatigue behaviour of rice husk ash Si_3N_4 and pineapple/basalt Fiber–reinforced polyester composite

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Abstract
The objective of this investigation was to develop lightweight polyester composites for possible application of human pros thetics. Since present materials in human prosthetics are either metals or synthetic harmful fibre and fillers, the present stud proposes to introduce a new alternative biocomposite material for manufacturing human prosthetics. Thus, in this study pineapple-basalt fibre sandwich with rice husk Si_3N_4 particle polyester composites was developed with two different stak ing sequences. The composites are prepared using the hand layup technique, and testing was carried out in accordance witl American Society of Testing and Materials (ASTM) standards. The highest measured mechanical values for composite des ignation PBS1 up to 124 MPa, 162 MPa, 4.68 J, 21 MPa, and 79 shore-D for tensile strength, flexural strength, Izod impact and hardness, respectively, when compared to all other composite designations. Corresponding to this, maximum fatigue lif counts of 14,370 were seen for composite designation PBS1 with 1.0 vol. % Si_3N_4 particles included. However, the highe wear resistances value up to 0.007 for wear loss and 0.028 for co-efficient of friction (COF) for composite designation PBS resulted from the enhanced Si_3N_4 particle volume percentage up to 3.0 vol. %. The scanning electron microscope (SEM fractography of the broken samples shows that the silane surface treatment has increased the interaction between the fibr and matrix phase. Thus, based on the present research, it is clear that the novel material structure (B/P/P/B) with pineapple basalt fibre and Si_3N_4 is capable of replacing the existing man-made synthetic materials used in human prosthetic productio with more advantageous attributes such as light weight, high strength, durable, abrasion resistance, and fatigue damage free

Keywords PMC · Fibre · Filler · Mechanical properties · Wear · Fatigue

1 Introduction

Polymer matrix composites are advanced structural materials made of strengthening fibres and fillers to reduce the cost and improve the load bearing properties. They are popularly used in many engineering applications, out of which an important application is human prosthetic application [1]. Because of superior mechanical, physical, and thermal resisting quali ties, polymeric materials play a significant role in prostheti gadget making applications. As of now, the prosthetic gadget are made of synthetic fibre and fillers [2]. However, extensiv use of these synthetic composites is polluting the environmen heavily as they are non-degradable. Thus, natural polyme composite is generally preferable over synthetic polymer because of their widespread acceptability, availability, an cost-effectiveness [3]. Recently, biofibres and fillers hav been added to the development of those prosthetic composit materials they receiving a lot of attention among researcher since they are capable in handling of applied loads and an harm environment [4]. Significant number of researchers i the area of prosthetic production is nowadays using natura fiber composite materials because they differentiate from typi cal materials in terms of their thermal, mechanical, and othe characteristics. Prosthetic parts that help people with disa bilities continue moving with greater freedom [5]. Syntheti prosthetic parts made of conventional materials are reportedl

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