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Fabrication and characterization of homogenous and functionally graded glass fiber reinforced polymer composites

Manoj Kumar Sain [a], Praveen Saraswat [a], Ajeet Kumar [b], Ananda Mohan Vemula [b]

[a] Swami Keshvanand Institute of Technology, Management and Gramothan, Jaipur, India
[b] Guru Nanak Institutions Technical Campus, Hyderabad, India

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Abstract

Composite materials are the most promising and distinctive materials to achieve higher strength to weight ratio, good stiffness and more cost-effectiveness The reinforcement and matrix are the two main components of any composite material. Fiber reinforced functionally graded resin-based polymer composite can be used in various applications where varying properties are desired. This paper presents the findings on physical and mechanical characteristics of glass fiber reinforced vinyl-ester based homogenous and functionally graded polymer composites. The homogenous polymer composites were fabricated by hand lay-up technique and functionally graded polymer composites were fabricated by centrifugal casting technique. The physical and mechanical characteristics like void fraction, water absorption, tensile strength, hardness, flexural strength, impact strength and microstructure were investigated to get detailed insights. The characteristics like void fraction, water absorption and tensile strength are found to be enhanced in case of homogenous polymer composite than functionally graded polymer composite, and this increase with fiber loading. Similarly, the hardness, impact strength and flexural strength are found to be increased with fiber loading in case of functionally graded polymer composite compared to homogenous polymer composite.

Introduction

Functionally graded materials (FGMs) have emerged as a new category of engineered materials in recent years and have been the topic of numerous studies. FGMs can be tailored for certain purposes and applications because to their unique structure. The FGMs can be altered in a certain direction depending on their design, microstructure, chemical content, and phase distribution. That is, the qualities gradually shift in that direction. Uses of homogeneous polymer matrix based composite materials are gradually increasing in the world for last few years. Homogeneous polymer matrix composite materials formed for different reinforcements and fillers have been motor vehicle parts, micro-electro-mechanical systems, marine, defense, biomedical, optics and small gear assemblies used in domestic appliances. There are various types of manufacturing techniques to make homogenous composite materials such as by hand mixing techniques, electric hand blender mixing method, dry process, dispersion, foaming and melt extrusion of a polymer powder. In various machine parts or structural members, abrupt change in material properties across the interface between dissimilar materials may cause high inter laminar stresses and this leads to deformation or cracking. This risk can be minimized by using gradual variation of material composition.

However, the research on theoretical implications of functionally graded structural materials was initiated about 1972, due to limitation of fabrication processes available at that time, further development was delayed. After some years, in 1984 the term “functionally graded material” was introduced in Japan for research and development of thermal barrier materials [1]. In functionally graded materials (FGM) the