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MECHANICAL PROPERTIES OF RAMIE POLYMER COMPOSITES: REVIEW

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Abstract

Presently, natural fibres are often used as reinforcement in polymer composites so as to improve the strength of polymer composites. Natural fibre besides being eco-friendly and abundantly available also reduces the consumption of expensive polymer resin. Excellent tensile strength and young's modulus makes it a worthy reinforcement to polymer composites. Thus, present review deals with the mechanical properties of ramie reinforced polymer composites.

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Impact strength, flexural strength and tensile strength of ramie composites are discussed. This study also provides an insight to the factors influencing mechanical properties of composites like treatments, fibre loading, polymer matrix and type of reinforcements. It also elucidates the future prospects on ramie fibre reinforced polymer composites.

1. Introduction

Natural fibres are reinforced in polymer composites because of their properties like good specific strength, light weight, eco-friendly, abundantly available and also reduces the overall cost of polymer composites. There are many natural fibres like abaca [1]-[3], jute [4], ramie [5], [6], sisal [7], coconut [8], bamboo [9], etc. which are utilized as reinforcement in polymer composites to improve strength of composites. Hybrid natural fibre reinforced polymer composites were also developed to achieve desired strength. Abaca fibre was used to strengthen epoxy composites along with red mud particles which helped in increasing the mechanical properties of polymer composites [10]. Here red mud was utilized as filler which not only enhanced mechanical properties of composites but also reduce the consumption of polymeric resin. It was also reported [11] that use of alkali and silane surface treatment have resulted in enhancing the wettability of bamboo composites which further led to increase in mechanical properties of composites. Research also showed that type of reinforcement and their composition in polymer composites significantly affects the mechanical characteristics of composites [12]. Orientation of fibre laminates in hybrid natural fibre reinforced composites also influences the mechanical properties of composites [13].

There are very few natural fibres whose strength is comparable to synthetic fibres like e-glass fibres and Ramie fibre is one of such natural fibre [14]. It is highly resistant to chemical and prevents the growth of bacteria too. It was observed in a study, that incorporation of more than 10wt.% of ramie fibre deteriorated the tensile strength of composites [15]. Moreover, ramie fibre extracted from different types of yarns too have significant effect of the mechanical properties of ramie reinforced polymer composites [16]. It is noticeable that, there is significantly lower volume of literature available on ramie fibre reinforced polymer composites despite its exceptional strength. Therefore, this review provides an overview of the mechanical properties (tensile, flexural and impact strengths) of ramie reinforced polymer composites based on types of polymer matrices, fibre loading, chemical treatments.

2. Mechanical Properties of Ramie Reinforced Polymer Composites

For utilization of polymer composites in various applications, it is needed to investigated their mechanical properties like impact strength, tensile strength and flexural strength. This helps in understanding the behavior of composites under different loading conditions. Moreover, for designing and development of composites, it is of vital importance to identify the major factors influencing these mechanical properties. For this purpose, study is categorized into three:

2.1 Tensile strength

Ramie fibre when used as reinforcement in Poly Lactic acid (PLA) matrix to investigate the effect of twist ratio on tensile strength of composites [17]. Highest tensile strength was observed for 0.3 twist ratio. Tensile strength first increased and then decreases with twist ratio. This deterioration in tensile strength was attributed to formation of voids due to increase in twist ratio which subsequently hindered the impregnation of ramie fibres. Another research reported increase in tensile strength of ramie reinforced polymer composites due to silane treatment which could be because of enhancement of interfacial adhesion between poly (l-lactic) acid matrix and ramie fibre [18]. Another study based on the investigation of mechanical properties of ramie, jute and roselle fibre reinforced unsaturated polyester composites reported that the ramie reinforced polymer composites showed maximum tensile strength in the direction of weft among all three composites [19]. Tensile strength of ramie reinforced Soy protein isolate composites also improved with wt.% of fibre and length of ramie fibre [20]. Similarly, ramie fibre was also used as reinforcement in bio-polyester composites which resulted in increasing the tensile strength of bio-polyester by 31% [21].

2.2 Flexural strength

Research reported that the flexural strength of ramie/PLA composites increased significantly by surface treatments by silane and alkali when compared to untreated composites [22]. However, it was also found that alkali treatment proved more advantageous than the silane treatment in enhancing flexural strength of ramie/PLA composites. Use of compatibilizer (Tri glycidyl isocyanurate) also resulted in enhancing flexural strength of ramie reinforced

PLA composites [23]. Effect of Amino silicone oil treatment of ramie fibre reinforced polypropylene composites was also investigated in research [24] which showed that interfacial adhesion increases with the treatment of ramie fibre significantly which was also attributed to decrease in hydrophilicity of ramie fibres. Influence of Diammonium phosphate (DAP) addition in ramie reinforced polymer composites was reported in a study [5] which showed that the flexural strength improves with incorporation of DAP. Results also manifested that combination of alkali and silane treatment resulted in deterioration of flexural strength of composites.

2.3 Impact strength

Impact strength of ramie reinforced polypropylene composite was investigated in research where it showed that on increasing the fibre loading, impact strength improved which could be due to addition of fibres which increases the energy required for failure of composites [15]. Moreover, adhesion between ramie fibre and polypropylene matrix plays vital role in deciding the strength of composite. Study based on the determination of mechanical properties of ramie fibre reinforced polymer composites [17] reveals that silane treatment increases the impact strength of composite drastically by 200%. Result also showed that increase in length of ramie fibre also improves the impact strength of composites.

3. Conclusions

This review delivers an overview on the recent development in mechanical properties of ramie fibre reinforced polymer composites. Influence of various factors like fibre loading, treatments, type of matrix and incorporation of other natural fibres are also elucidated. It was inferred from the literature that ramie fibre reinforced in PLA, bio-epoxy and bio polyamides exhibited superior tensile, flexural and impact strengths. However, surface treatment like Pectinase enzyme and silane proved to be more beneficial in improving the mechanical performance of ramie composites. Mechanical attributes of ramie composite improve with increase in ramie fibre content.

For wide range of application of ramie fibre reinforced polymer composites, it is needed to explore the potential of ramie fibre with other polymer matrices and natural fibres. Hybrid composites based on ramie fibre

might result in achieving better mechanical properties. Moreover, studies pertinent to optimization and modelling of ramie fibre reinforced polymer composites are limited but could be helpful in saving resources.

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