Organic and Medicinal Chemistry
International Journal
ISSN 2474-7610

Juniper PUBLISHERS key to the Researchers

Mini Review
Volume 4 Issue 1 - September 2017
DOI: 10.19080/OMCIJ.2017.04.555628

Organic & Medicinal Chem IJ

Flame Retardancy and Tribological Behavior of Natural Fibre Reinforced Composites: A review

Vinay Mishra and Anshuman Srivastava*

Mechanical Engineering Department, India

Submission: September 21, 2017; **Published:** September 27, 2017

*Corresponding author: Anshuman Srivastava, Mechanical Engineering Department, SIET Allahabad, India; Email: anshuman0203@gmail.com

Abstract

Natural fibers being ecofriendly and sustainable in nature attract lot of researchers and engineers for their utilization in polymer composites. The properties of NFPCs vary with fiber type, orientation of fibers, aspect ratio of fibers and interface bonding. Few drawbacks of NFPCs are high water absorption, poor fire resistance and lower mechanical properties which limits their applications. Effects of chemical treatment on the flames retardancy, tribology and water absorption of NFPCs are highlighted in the present investigation. The applications of NFPCs include automobile, construction industry and for several structural purposes. Coatings and additives are very effective in fire barrier treatments. Most widely used fire barriers are aluminum hydroxide [Al(OH3)] and magnesium hydroxide [Mg(OH)2]. Natural fiber mats, in PLA matrix, is capable of enhancing wear and frictional resistance of neat polymers.

Keywords: (a) NFPCs; (b) Tribology; (c) Flame retardant; (d) Mechanical properties

Abbreviations: FR: Flame Retardant; EG: Expandable Graphite; APP: Ammonium Polyphosphate; GRP: Glass Fiber/Polyester; SCRP: Sugarcane Fiber Reinforced Polyester; OPEFB: Obsorption Properties Of Oil Palm Empty Fruit Bunch

Introduction

Natural fibers being ecofriendly and sustainable in nature attract lot of researchers and engineers for their utilization in polymer composites. The aim of this review article is to provide a comprehensive review on the flame retardancy and tribological behaviour of the widely used natural fiber reinforced polymer composites (NFPCs) and their applications. It also covers summary of various surface treatments applied to natural fibers and their effect on different properties of NFPCs. The properties of NFPCs vary with fiber type, orientation of fibre, aspect ratio of fibres and interface bonding. Few drawbacks of NFPCs are high water absorption, poor fire resistance and lower mechanical properties limits their applications. Impacts of chemical treatment on the flames retardancy, tribology and water absorption of NFPCs are highlighted in this study. The applications of NFPCs include automobile, construction industry and for structural purposes. Chemical treatment of the natural fiber improves the adhesion between the fiber surface and the polymer matrix which ultimately results in enhanced physical and mechanical properties of the NFPCs [1-4].

Flame Retardancy of the NFPCs

Flame retardancy is another very important property from safety point of view while developing natural fiber composites. There are two forms of products that are obtained upon burning of composites; these are high cellulose content and high lignin content. High cellulose promotes higher flammability whereas higher values of lignin show there is a greater chance of char formation [5,6]. Flax fibers are thermal resistant [4-7]. Silica or ash is another important feature that helps extinguishing fire [5-9]. Coatings and additives are very effective fire barrier treatments in which these barriers are expanded upon heating resulting in a cellular surface that is charred even. This charred surface protects the internal or underlying components against flux and heat. One of the well-known flame retardants for reinforced polymers is char developing cellulose material (natural fibers) [8-13]. The only way of reducing combustion is by increasing stability and char formation in the polymer. This results in decreased flammability, decrease visible smoke and restrict the volume of products produced due to combustions [12-14].

The two most widely used metal hydroxide flame retardants are known to be aluminum hydroxide [Al (OH3)] and magnesium hydroxide [Mg(OH)2] which are purposefully added to polymers. It was also shown in a research that the addition of Expandable Graphite (EG) and Ammonium Polyphosphate (APP) in composite polymer as a source of Flame Retardant (FR) helps in enhancing flax fiber reinforced PP composite's property of fire retardancy. Hapuarachchi and Peijs [3] reported the enhanced features of fire or flame retardancy in fully bio-based natural fiber composite. This natural fiber composite was developed with the help of PLA polymers that were derived from crops accompanied with 2 kinds of nanofillers which are able to produce synergy corresponding to flame retardancy.

At temperatures around 240°C, natural fibers start degrading whereas constituents of fiber, such as hemicelluloses, cellulose, lignin, and others, start degrading at different levels of temperature; for example, at 200°C lignin starts to decompose whereas at temperatures higher than this other constituents will also degrade [13-16].

Since thermal stability of the fibers is dependent on the structural constituents of fibers, it can be improved if the concentration levels or the structural constituents are completely removed, such as lignin and hemicelluloses. This can be achieved with the help of chemical treatments. Natural fibers have a short lifetime with minimum environmental damage upon degradation whereas synthetic ones affect environment due to pollution caused by degradation. More than fifty percent weight of jute or Biopol composite is lost after exactly 1500 days of burial [14-18].

Tribological behavior of the NFPCs

Since every material has some wear and friction properties that degrade with respect to time, the tribological loadings are important to consider for an improved mechanical part design [12]. Around 90% failure is obtained due to differences in tribological loading conditions which alters their wear and friction properties . Reinforcement is a method with which fiber's or polymers tribological properties can be altered. Studies on different kinds of tribological analysis have been conducted on fibers including kenaf/epoxy [12-13], betel nut fiber reinforced polyester, sisal/phenolic resin, Sugarcane Fiber Reinforced Polyester (SCRP), and cotton/polyester [11-14]. Improvement in wear performance of PLA was evident due to the addition of natural fibers in which wear rate of composites was quite low in comparison to wear rate at higher loads on neat PLA [5-8].

Wear and friction of Glass Fiber/Polyester (GRP) and Sugarcane Fiber/Polyester (SCRP) were studied by El-Tayeb. They considered different parameters like speed, the time taken for test, and load [12]. The research showed that SCRP as a good competitor of GRP composite. Xin et al also reported the same characteristics for sisal fiber reinforced resin brake composites. They reported that sisal fiber can be a good replacement of asbestos in brake pads [4].

The research results showed infusion of natural fiber mats, in PLA matrix, is capable of enhancing wear and frictional resistance of neat polymers. An approximate reduction of 10-44% in the coefficient of friction with a greater reduction of 70% seen in developed composites for specific wear rate is visualized in comparison to neat PLA [6-13].

Moisture absorption of NFPCs

However, the main drawback of the application of natural fibers is their susceptibility to moisture. Mechanical properties of polymeric composites have a strong dependence on the interface adhesion between the fiber and the polymer matrix [14-18]. The natural fibers are rich of cellulose, hemicelluloses, lignin, and pectins, all of which are hydroxy 1 group. They are usually hydrophilic in nature and strong polar, while polymers show considerable hydrophobicity. Thus, there are major challenges of suitability between the matrix and fiber that weakens interface region between matrices and natural fibers [10-14].

Many researchers [9-15] studied the effect of coupling agent such as maleic anhydride polyethylene and chemical treatments on reduction moisture absorption of NFPCs. chemical treatments such as bleaching, acetylation and alkali treatment are very effective in reducing moisture absorption of NFPCs. The surface of the fibers is cleaned during the chemical treatments to ensure there are no impurities which increases the fiber surface roughness and preventing the moisture absorption via the removal of the coat of OH groups of fiber [11-17]. Sreekala and Thomas [5] investigated the moisture Absorption Properties of Oil Palm Empty Fruit Bunch (OPEFB) fiber in different temperature condition. They also studied the effect of different modification on OPEFB fiber, such as silane treatment, gamma irradiation, latex coating, mercerization, acetylation, peroxide treatment, and isocyanates treatment on moisture absorption properties. They concluded that all the treatment causes the reduction in moisture absorption properties in all temperatures.

Conclusion

High cellulose promotes higher flammability whereas higher values of lignin show there is a greater chance of char formation. Silica or ash is another important feature that helps extinguishing fire. Coatings and additives are very effective fire barrier treatments in which these barriers are expanded upon heating resulting in a cellular surface that is charred even. This charred surface protects the internal or underlying components against flux and heat. It was found that natural fiber mats in PLA matrix, is capable of enhancing wear and frictional resistance of neat polymers. Silane treatment, gamma irradiation, latex coating, mercerization, acetylation, peroxide treatment, and isocyanate treatments are found to be very effective in reducing the moisture absorption of NFPCs.

How to cite this article: Vinay M, Anshuman S. Flame Retardancy and Tribological Bhaviour of Natural Fber Rinforced Cmposites: A Rview. Organic & Medicinal Chem IJ. 2017; 4(1): 555628. DOI: 10.19080/OMCIJ.2017.04.555628.

References

1. MM Kabir, H Wang, KT Lau, F Cardona (2012) Chemical treatments on plant-based natural fibre reinforced polymer composites: an overview. Composites Part B: Engineering 43(7): 2883-2892.
2. MJ John, S Thomas (2008) Biofibres and biocomposites. Carbohydrate Polymers 71(3): 343-364.
3. TD Hapuarachchi, T Peijs (2010) Multiwalled carbon nanotubes and sepiolite nanoclays as flame retardants for polylactide and its natural fibre reinforced composites. Composites Part A: Applied Science and Manufacturing 41(8): 954-963.
4. X Xin, C G Xu, LF Qing (2007) Friction properties of sisal fibre reinforced resin brake composites. Wear 262(5-6): 736-741.
5. MS Sreekala, S Thomas (2003) Effect of fibre surface modification on water-sorption characteristics of oil palm fibres. Composites Science and Technologyl 63(6): 861-869.
6. S Shinoj, R Visvanathan, S Panigrahi, M Kochubabu (2011) Oil palm fiber (OPF) and its composites: a review. Industrial Crops and Products 33(1): 7-22.
7. IS MA Tawakkal, MJ Cran, SW Bigger (2014) Effect of kenaf fibre loading and thymol concentration on the mechanical and thermal properties of PLA/kenaf/thymol composites. Industrial Crops and Products 61: 74-83.
8. CC Eng, NA Ibrahim, N Zainuddin, H Ariffin, WM ZW Yunus (2014) Impact strength and flexural properties enhancement of methacrylate silane treated oil palm mesocarp fiber reinforced biodegradable hybrid composites. The Scientific World Journal: p. 8.
9. M Sain, SH Park, F Suhara, S Law (2004) Flame retardant and mechanical properties of natural fibre-PP composites containing magnesium hydroxide. Polymer Degradation and Stability 83(2): 363-367.
10. E Gallo, B Schartel, D Acierno, F Cimino, dP Russo (2013) Tailoring the flame retardant and mechanical performances of natural fiber-reinforced biopolymer by multi-component laminate. Composites Part B: Engineering 44(1): 112-119.
11. NPG Suardana, MS Ku, JK Lim (2011) Effects of diammonium phosphate on the flammability and mechanical properties of bio-composites. Materials & Design 32(4): 1990-1999.
12. NSM El-Tayeb, BF Yousif, TC Yap (2006) Tribological studies of polyester reinforced with CSM 450-R-glass fiber sliding against smooth stainless steel counterface. Wear 261(3-4): 443-452.
13. CW Chin, BF Yousif (2009) Potential of kenaf fibres as reinforcement for tribological applications. Wear 267(9-10): 1550-1557.
14. A Srivastava, M Maurya (2015) Preparation and Mechanical Characterization of Epoxy based composites developed by Bio waste. IJRET 4(4):2319-1163.
15. V Mishra, A Srivastava (2014) Epoxy/Wood Apple Shell Particulate Composite With Improved Mechanical Properties. International Journal of Engineering Research and Applications 4(8): 142-145.

16 A Srivastava, PralayMaiti, Devendra Kumar, Om Parkash (2014) Mechanical and dielectric properties of CaCu3Ti4O12 and La doped CaCu3Ti4O12 poly (vinylidene fluoride) composites. Composites Science and Technology 93: 83-89.

17 IS MA Tawakkal, MJ Cran, SW Bigger (2014) Effect of kenaf fibre loading and thymol concentration on the mechanical and thermal properties of PLA/kenaf/thymol composites. Industrial Crops and Products 61: 74-83.

18 K Bocz, B Szolnoki, A Marosi, T Tábi, M Wladyka-Przybylak, et al. (2014) Flax fibre reinforced PLA/TPS biocomposites flame retarded with multifunctional additive system. Polymer Degradation and Stability 106: 63-73.

DOI: 10.19080/OMCIJ.2017.04.555628

How to cite this article: Vinay M, Anshuman S. Flame Retardancy and Tribological Bhaviour of Natural Fber Rinforced Cmposites: A Rview. Organic & Medicinal Chem IJ. 2017; 4(1): 555628. DOI: 10.19080/OMCIJ.2017.04.555628.