A Review on Properties and Applications of Polymer Matrix Composites

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Abstract – **The last two decades have witnessed large increase in the use of composite materials. Specific strength and specific modulus of composite materials is very high as compared to metallic counterparts. Polymer matrix composites (PMCs) are in comparison with metal and ceramic matrix composites the most widely used composites. This is caused by their good properties and relative easy processing. Depending upon the type of fibre used, the costs are low (glass fibre reinforced plastics, GFRPs) to moderate (carbon fibre reinforced plastics, CFRPs). Chief among the advantages of PMCs is their light weight coupled with high stiffness and strength along the direction of the reinforcement.**

Keywords— **Polymer matrix composites, Natural fiber composites, electrical properties, mechanical properties.**

I. INTRODUCTION

Polymer matrix composites are comprised of a variety of short or continuous fibres bound together by an organic polymer matrix in which the strong reinforcing dispersed phase provides high strength and stiffness. They were designed so that the mechanical loads to which the structure is subjected in service are supported by the reinforcement. The function of the matrix is to bond the fibres together and to transfer loads between them. Polymer Matrix Composites are very popular due to their low cost and simple fabrication methods. Use of non-reinforced polymers as structure materials is limited by low level of their mechanical properties, in addition to relatively low strength; polymer materials possess low impact resistance. Mechanical performance is generally optimized by trial and error until the functional demands of the design are satisfied. [1]

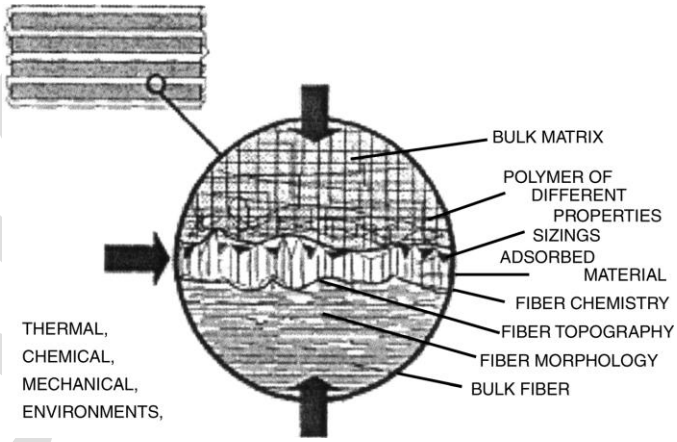

Fig.1 Schematic model of interphase [2]

II. PROPERTIES

A. Electrical Properties

The electrical properties of natural fiber reinforced polymer composites are very important. Due to their unique the inorganic insulators and dielectrics have been replaced by polymers for specific needs. Epoxides and polyesters have been used in electronics as insulators, dielectrics substrates, potting compounds, embedding materials and conformal coating. The moisture content in fibers increases conductivity of the composites. . It has been found that heat treatment increased the resistivity of the composites as heat treated fiber reinforced composites. The increase of dielectric constant with temperature is due to greater freedom of movement of dipole molecular chain at high temperature. It has been observed that dielectric dissipation factor increased with temperature and decreased with frequency. It has been further observed that dielectric loss decreased with the increase of frequency at fixed temperature. It can be concluded that with systematic

and persistent research there will be good scope and better future for polymer reinforced composites for suitable electrical applications such as terminals, connectors, switches, circuit boards etc. [3]

B. Mechanical Properties

PMCs are very popular due to their low cost and simple fabrication methods. Use of non-reinforced polymers as structure materials is limited by low level of their mechanical properties, namely strength, modulus, and impact resistance. Reinforcement of polymers by strong fibrous network permits fabrication of PMCs, which is characterized by the following properties high specific strength, high specific stiffness, high fracture resistance, good abrasion resistance, good impact resistance, good corrosion resistance, good fatigue resistance, low cost. The main disadvantages of PMCs are low thermal resistance and high coefficient of thermal expansion. [2]

III. APPLICATIONS

A. Applications in automotive industry

Most of the car companies in the world have done a lot of investigation in order to insert the Natural fiber polymer composites (NFPCs) in their products. They are used in car interior such as seat backs, parcel shelves, boot linens, front and rear door linens, truck linens, and door-trim panels. Beside the use for car interior parts in automobile industry, natural fiber embedded in polymers has been used for high requirement applications for exterior auto body components, such as the middle section between the headlights above the fender of a passenger bus. German auto companies (BMW, Audi Group, Ford, Opel, Volkswagen, Daimler Chrysler, and Mercedes) utilize the cellulose fibers composites in various automobile part, shown in Figure 2, such as using coconut fibers rubber latex composites for the seats of the Mercedes Benz A-class model and using fax-sisal fiber mat reinforced epoxy door panels of Mercedes Benz E-class model. Volkswagen company used cellulose fiber to make Seatback, door panel, boot-lid finish panel, boot-liner in Passat Variant, Golf, A4 and Bora model. BMW Group has a lot of NFPCs into its automobiles. Each BMW 7 series car boats 24 kg of renewable raw materials, with flax and sisal in the interior door lining panels. Daimler-Benz has developed the dashboards and center armrest consoles along with seat shells and paneling on seat backs. Moreover, it increased the utilization of NFPCs in some automobiles by approximately 98% over earlier models by utilizing natural fibers, for example, abaca and flax. On the other hand, the Cambridge industry made rear shelf trim panels of the 2000 model Chevrolet Impala using flax fiber polypropylene composite. Toyota, Proton, Volvo, and other automobile companies used cellulose fiber to make car parts. [4]

Fig.2 Automobile components made of natural fiber composites [4]

B. Applications in the Industry

The wide advantages of natural fibers reinforced composites such as high stiffness to weight ratio, lightweight and biodegradability give them suitability in different application in building industries. Van de Weyenberg et al. have shown that good properties of thin walled elements such as high strength in tension and compression, made of sisal fiber reinforced composite, give it a wide area of application, for instance, structural building members, permanent formwork, tanks, facades, long span roofing elements, and pipes strengthening of existing structures. On the other hand, bamboo fiber can be used in structural concrete elements as reinforcement, while sisal fiber and coir fiber composites have been used in roofing components in order to replace asbestos. Natural fiber reinforced concretes products in construction applications like sheets (both plain and corrugated) and boards are light in weight and are ideal for use in roofing, ceiling, and walling for the construction of low-cost houses .[4]

IV. CONCLUSION

This brief review of polymer matrix composites has summarized the very broad range of unusual functionalities that these products bring. While the properties play an important role in defining the scope of applications for which these materials are suited, it is equally important that the final parts are designed to maximize the value of the inherent properties of these materials.

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