Glass Fibre reinforced Polycarbonate for Automobile Chassis Application

Srimurugan R[1]*, Vijay Ramnath[2], Ananthapadmanaban D[3], N. Ramanan[4]
[1]Department of Mechanical Engineering, AMET University, Chennai - 603112.
[2]Department of Mechanical Engineering, Sri Sairam Enginnering College, Chennai - 600044.
[3]Department of Mechanical Engineering, SSN College of Engineering, Chennai - 603110.
[4]Senior Engg, R&D, Synce Engineering Service, Chennai.
[*]Corresponding author: E-mail: rsrimurugan@gmail.com

ABSTRACT

Polycarbonate glass fibre reinforced composite has been researched upon for use in automobile chassis application. Two different percentages of glass fibres have been studied while manufacturing and mechanical properties have been studied. It was found that 10% glass fibre reinforced composite shows better tensile and flexural strength. It also shows better hardness compared to 20% glass fibre composite.SEM Micrographs were analyzed for the mode of fracture.

KEY WORDS: Glass fibre, Injection molding, Flexural strength, SEM.

1. INTRODUCTION

In most of the automobiles audio chasses manufactured by using ABS plastic material. In the polycarbonate and acrylonitrile–butadiene–styrene copolymer disadvantages are limited weathering resistance, relatively good heat, moisture and chemical resistance, high cost and flammable with high smoke generation. To overcome the problem, polycarbonate and glass fiber is being tried out in the chassis system. Because it can easily be moulded into the desired shape and has mechanical strength that is so strong and stiff for its weight that it can out-perform most of the other materials. And it is low maintenance, anti-magnetic, fire resistant, good electrical insulator and weatherproof.

Literature Survey: AttelManjunath (2010), have worked on mechanical property testing of glass reinforced Polycarbonate. Surface hardness measurements by Shore schelorescope method have revealed that the hardness values vary between 87-93 and Tensile strength varied between 80-107 MPa. It has researched upon and revelead that glass fibre reinforced Polycarbonate can be recycled and an elaborate work on this aspect has been done by (Chu, 1996).

Friction and wear tests have been performed on a glass fibre reinforced polycarbonate with a 20wt 5 glass fibre.The tests were done with a ball-on-plane tester. Scanning electron microscopy was used to examine details of the worn surface. The optimum conditions were found to be a filling time of 5 seconds and melt temperature of 290 Celcius.

Injection moulding conditions for lowest wear volume loss were found to be a filling time of 5 s, melt temperature of 290°C, and mould temperature of 80°C, when the sliding direction is parallel with the melt flow direction. Grooves, debonding of fibres, fibre cutting and presence of microcracks are the major wear mechanisms found in wear tests of short glass fibre reinforced polycarbonate. Optimization of parameters used in injection molding parameters have been carried out. The methodology used in this research is a combination of of the GRA (grey relational analysis) method and a CAE flow simulation software. This method helps to simulate the injection molding process and to predict the fiber orientation. The results show three distinct layers (a frozen layer, a shear layer and a core layer).These layers are are observed progressively from the surface to the core for various injection molding conditions. (Franzen, 1989). Flexural properties of glass fibre reinforced polycarbonate have been studied for orthodontic applications. The method of manufacture used is pultrusion. There is a possibility of some fibre degradation during injection molding and studies have been done on this aspect.

2. EXPERIMENTAL WORK

Figure.1. Paper clip mold opened in molding machine

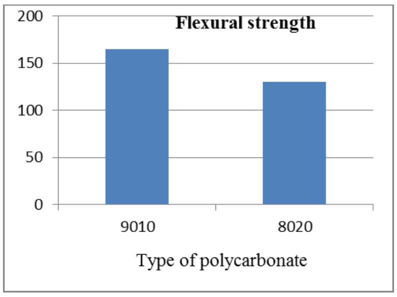
In this work, 2 different percentages of glass fibre, namely 10% and 20 % have been used. They have been mixed with the Polycarbonate in an injection molding machine whose description is given below.

Injection molding has been used to fabricate the glass fibre reinforced composite. The parts of an Injection molding machines are- material hopper, an injection ram or screw-type plunger, and a heating unit. They are also known as presses. Their purpose is to hold the molds in which the components are shaped. Presses are rated by tonnage, which is a measure of the amount of clamping force that the machine can exert. The purpose of this force is to keep the mold closed during the injection process. Tonnage usually ranges from less than 5 tons to over 9,000 tons. Higher tonnages are used in some select, specialized manufacturing operations. The total clamp force needed is determined by the projected area of the part being molded. The projected area so obtained is multiplied by a clamp force of from 1.8 to 7.2 tons for each square centimetre of the projected areas. A common rule of thumb states that 4 or 5 tons/in^2 is preferrable for most products. In the likelihood of working with a stiff plastic material plastic, more injection pressure would be required to fill the mold. It follows that a higher clamp tonnage is needed to hold the mold closed. The force required to hold in place can also be determined by the material chosen for use and the size of the part; larger parts need higher clamping force.

Flexural strength, hardness tests and tensile strength have been calculated for both the compositions and results have been analyzed. SEM Micrograph of the surface after tensile test has been taken using Zeiss model Scanning Electron microscope.

3. RESULTS AND DISCUSSION

Flexural strength of 10% glass fibre composite (9010) is higher than 20% (8020) glass fibre as given in Figure 2.



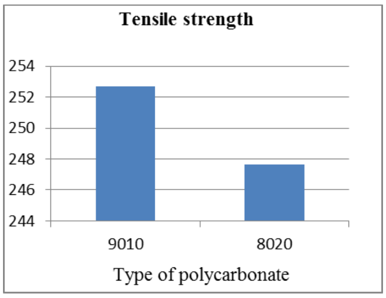


Figure. 2. Tensile strength in N/m^2 Figure.3. Flexural strength in N/m2

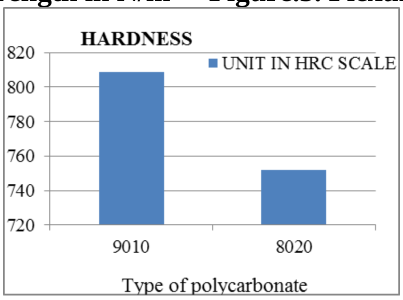


Figure.4. Hardness variation

Hardness comparison between 10% (9010) and 20 % (8020) glass fibre is given in Figure.4.

Glass fibre has a higher hardness and strength than Polycarbonate. So, it is expected that addition of glass fibre will increase the strength and hardness. Some of the literature reviewed have also shown this trend. However, in our case, strength and hardness have decreased. This could possibly be due to the fact that optimum glass fibre % age may be between 10 and 20% and then hardness and tensile strength have started decreasing. Addition of more than the optimum glass fibre may give rise to areas of crack initiation a little earlier (glass fibre being brittle).When more cracks are initiated, it is expected that the material will fail earlier. The same explanation may hold true for the lower hardness value.

SEM Studies: SEM studies were done on a Zeiss model SEM under 1000 x magnification. A typical SEM micrograph is given below.

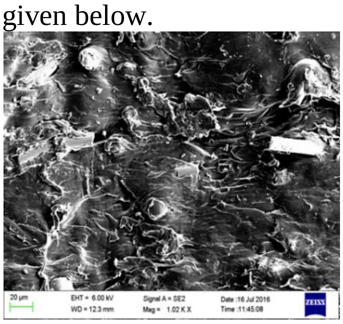


Figure. 5. SEM for 10% glass fibre

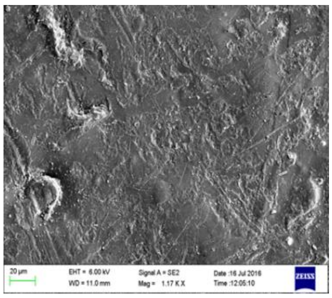


Figure. 6. SEM Micrograph for 20% glass fibre

The micrograph shows some flow lines. The fracture appears to be in the mixed mode. This could be due to presence of brittle glass fibre in the plastic polycarbonate matrix. Matrix could have deformed to some extent which explains the deformation seen in the SEM photograph, but glass fibre has an opposing effect and induces some degree of brittleness.

SEM Micrograph in this case shows some differences compared to the 10 % glass fibre composite. It seems that the fracture is more brittle in nature. There is complete lack of plastic flow lines. There is no evidence of fibre pull out as a fracture mechanism in these 2 cases and more research needs to be done with more variation of glass fibre reinforcement. One study has revealed that fibre pull out occurs for 40 % glass fibre reinforcement in polycarbonate (Hua, 2010). In the same study, it was shown that glass fibre bonded well with the Polycarbonate, but Carbon fibre did not bond well and fibre pull out as a failure mechanism was seen.

4. CONCLUSIONS

Flexural strength of 10% glass fibre composite was around 160 N/m^2 compared to around 130 N/m^2 for 20% glass fibre composite. Tensile strength variation was marginal and the increase was from 247 to 253 N/m^2.Hardness variation was also significant 750 to 810 HRC. SEM Micrograph showed good bonding as evidenced from the lack of fibre pull out.

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