Glass Fiber Wood Flour Polypropylene Hybrid Composites

Dr Vinay Kumar,
Assistant Professor, Department of Chemical Engineering,
Sant Longowal Institute of Engineering and Technology (SLIET), Longowal,
Distt. Sangrur -148106 (Punjab) India.
E mail: vinay652001@yahoo.co.in

Abstract: Abundantly available wood flour was used in polypropylene (PP) for making thermoplastics composites. Adhesion between PP and wood flour (WF) was enhanced by using maleated poly propylene (MAPP) compatabilizer which have positive effect on the tensile strength . Optimum use of glass fiber is required for getting maximum improvement in mechanical properties.. Howeever, hardness increase with increase in percentage of glass fiber . Composites thus prepared have applications in building and automotive fields.
Keywords: glass fiber, impact, polypropylene, tensile, wood flour

Introduction: Lingnocellulosic materials such as rice husk, bagasse, wood flour, sisal/jute fiber had become very popular for making thermoplastic composites due to low cost, light weight and biodegradable nature [1-2]. Addition of these materials in thermoplastics decreased the mechanical strength due to poor bonding [3]. Adhesion between the two was improved by using suitable compatabilizer and coupling agents. Due to better adhesion composites produced, have better tensile strength [4-6]. Use of glass fiber in small quantity produced hybrid composite with better impact strength.[7-11]. Wollastonite and glass fiber can be used with wood flour polypropylene composites for preparing hybrid composites. Use of glass fiber in small quantity produced hybrid composites with better thermal stability for heat resistance applications.[12]

In the present study, influence of addition of glass fiber on mechanical properties such as tensile, impact, flexural and hardness is attempted to explore new application in automotive and building fields.

Materials and Method:

MATERIALS:

Polypropylene: It was procured from M/S Reliance industries (Grade AM 120N) and following properties were measured:

- Moisture content (ASTM D789) : 0.039 %
- Viscosity average molecular weight (ASTM D 2857-95) : $26{,}592\times10^{-3}$ kg /mole
- Tacticity : 7.8%
- MFI (ASTM D 1238): 19.92×10^{-5} kg /s
- Tensile strength at yield (ASTM D 638): 29.0×10^{6} kg/ms^2
- Hardness SHORE D (ASTM D 2240): 63.75

Wood Flour: It was procured locally and some of the measured properties are :

- Bulk density (ASTM D1895) : 150 kg/m^3
- Ash content (ASTM D2584) : 9.59 %
- Moisture content (ASTM D789) : 9.02 %

MAPP Compatabilizer: Maleic anhydride grafted polypropylene (Grade P 406) compatibilizer was supplied by M/S Pluss Polymers Private Limited, Gurgaon

METHOD: Wood flour was preheated in oven at 373 K to remove moisture. Polypropylene along with wood flour was fed in a single screw extruder and temperature setting was: 463 K, 473 K, 483 K, and 473 K. After getting the uniformly mixed granules from the extruder, the granules were kept in the mold. Mold halves were kept in compression molding machine at following process conditions:

•

Processing temperature: 473 K
Heating time: 900 sec
Cooling time: 1200 sec
Clamping pressure: 590.5×10^4 kg/m^2

After proper heating and cooling of the mold, it was opened and composite sheets of 0.155m × m×0.003 m were produced. The sheet was cut to prepare samples for carrying out tensile, impact (ASTM D 256) and flexural (ASTM D 790) tests.
Universal testing machine (UTM) [Capacity: 50×10^3 kg m/s^2) , supplied by M/S Ashian Engineers Company India, New Delhi was used for performing the tensile and flexural test. Gauge length was fixed at 50×10^{-3} m and testing speed was set at 83×10^{-5} m/s. The sample size in flexural test was 0.1550 m× 0.0127 m×0. 003m and test was performed on the same UTM by three point loading. Sample size used in impact test was 0.0635 m0.0127× m×0.003 m. and was done by Izod method and un notched sample was used. The Shore D tester was used for hardness measurement and sheet of 0.155 m× 0.155 m× 0.003 m prepared by compression molding was used for this test.

Glass Fiber : It was supplied by M/S Dnd fiber glass P Ltd, New Delhi with following properties:

- Dielectric strength :102 KV/Cm
- Tensile Strength : 3100-3800 M Pa
- Elongation at break : 4.6%
- Young Modulus :80 GPa
- Coefficient of linear expansion :6.0

METHOD: Wood flour was preheated in oven at 373 K to remove moisture. Polypropylene along with wood flour and glass fiber was fed in a single screw extruder and temperature setting was: 463 K, 473 K, 483 K, and 473 K. After getting the uniformly mixed granules from the extruder, the granules were kept in the mold. Mold halves were kept in compression molding machine at following process conditions:
Processing temperature: 473 K
Heating time: 900 sec
Cooling time: 1200 sec
Clamping pressure: 590.5×10^4 kg/m^2

After proper heating and cooling of the mold, it was opened and composite sheets of 0.155m × 0.155 m×0.003 m were produced. The sheets were cut to prepare samples for carrying out tensile (ASTM D 638):, impact (ASTM D 256) and flexural (ASTM D 790) tests.
Universal testing machine (UTM) [Capacity: 50×10^3 kg m/s^2) , supplied by M/S Ashian

Engineers Company India, New Delhi was used for performing the tensile and flexural test. Gauge length was fixed at 50×10^{-3} m and testing speed was set at 83×10^{-5} m/s. The sample size in flexural test was 0.1550 m× 0.0127 m×0. 003m and test was performed on the same UTM by three point loading. Sample size used in impact test was 0.0635 m 0.0127× m×0.003 m. and was done by Izod method with un notched sample . The Shore D tester was used for hadrness hardness measurement ASTM D 2240), and sheet of 0.155 m× 0.155 m× 0.003 m^3 prepared by compression molding was used for this test.

Results and Discussion:

In the Table 1, results for mechanical properties (tensile, flexural,impact)

with glass fiber loading are reported. It is found that mechanical properties such as tensile, impact and flexura increase up to 1.5%, thereafter decrease due to deboning in .[13]. Therefore 1.5% is the optimum level required for good mechanical strength in WFPP composites as shown in Figure 1.

Glass fiber acts as nucleating agent which enhance the % crystallinity of composites. Tensile strength is directly related with % crystaalinity, therefore is improved.[14] Flexural strength or the bending strength also showed the similar trend as it is dependent on tensile and compressive properties.[15].After that both properties decreases . Both exhibited maximum value and showed decrease at high glass content.[16].

Impact strength increase with glass fiber content due to fiber pull out phenomenon. Dissipative mechanism through relative motion between polymer and fiber is the main reason . Reduction in stress concentration point due to filling of voids and interspaces between WF and PP is another reason for getting better impact strength in composites. Upto certain point. Hardness of WFPP composites increase with glass fiber loading due to high density of glass fiber and filling of voids/interspaces in composites..[17]

References:

1. L. Mantia and M. Morreale ," Green composites: A brief review", *Composites Part A: Applied Science and Manufacturing*, vol.42, pp *579-588, June 2011.*

2. G.Julia, M.Wagner , Florentino, Daniella, and R. Mulinari."Chapter 4 - Thermoplastics Polymers Reinforced with Natural Fibers",*Design and Applications of Nanostructured Polymer Blends and Nanocomposite Systems, pp. 55-73*, September 2015.

3. H. Zhang, "Effect of a novel coupling agent, alkyl ketene dimer, on the mechanical properties of wood–plastic composites",*Materials & Design, Vol. 59, pp. 130-134, July 2014.*

4. . M.B. Sonia, N., Graziela S. Cerveira, and M.L. R. Simone,"New polymeric-coupling agent for polypropylene/wood-flour composites",*Polymer Testing, Vol. 26, pp.619-628 ,August 2007.*

5. Janecska Z. Szabó, Gábor N., J. Móczó, and B. Pukánszky," Wood flour filled PP composites: Compatibilization and adhesion"*Composites Science and Technology, Vol. 7, pp.2838-2846 ,October 2007.*

6 L.Dányádi, T. N. Othman, H. Ismail, and M. Mariatti,".Effect of compatibilisers on mechanical and thermal properties of bentonite filled polypropylene composites",*Polymer Degradation and Stability, Vol. 91, pp. 1761-1774 , August 2006.*

7. J.Himani, and. J.Purnima ,"Development of glass fiber, wollastonite reinforced polypropylene hybrid composite: Mechanical properties and morphology,"*Materials Science and Engineering: A, Vol. 527, pp. 1946-1951 ,March 2010.*

8. V., Fabrizio Sarasini, F. Marra, J. Tirillò,and G.Pulci,,."Recycled glass fiber/wood flour thermoplastic composites: Manufacturing and mechanical characterization",*Composites Part A: Applied Science and Manufacturing, Vol. 42, pp.649-657, June 2011*.

9. H Hamada, K Fujihara,and A Harada,"The influence of sizing conditions on bending properties of continuous glass fiber reinforced polypropylene composites",*Composites Part A: Applied Science and Manufacturing, Vol. 31, pp.979-990, September 2000*.

10. M. Etcheverry, M. Luján Ferreira, N. Capiati, and S. Barbosa ,"Chemical anchorage of polypropylene onto glass fibers: Effect on adhesion and mechanical properties of their composites",*International Journal of Adhesion and Adhesives, Vol.43 , pp. 26-31 , June 2013*.

11. P. Russo, D. Acierno, G. Simeoli, S. Iannace, and L. Sorrentino.,".Flexural and impact response of woven glass fiber fabric/polypropylene composites",*Composites Part B: Engineering, Vol. 54, pp. 415-421 ,November 2013*.

12.M.A. AlMaadeed , Mabrouk Ouederni, P. Noorunnisa Khanam," Effect of chain structure on the properties of Glass fibre/polyethylene composites", Materials and design, Vol.47, pp. 725– 730, May 2013,.

13. M, A. AlMaadeed[a, ,] R. Kahraman, P. N. Khanam, and N. Madi[a]," Date palm wood flour/glass fibre reinforced hybrid composites of recycled polypropylene: Mechanical and thermal properties", Materials & Design, Vol.42, pp.289–294, December 2012.

14. V. shah, " Handbook of Plastics Testing and Failure Analysis", 3rd Edition, pp.648 ,2006.

15.H.Himani and J.Purnima ,"Development of glass fiber, wollastonite reinforced polypropylene hybrid composite: Mechanical properties and morphology,"*Materials Science and Engineering: A, Vol. 527, pp. 1946-1951 ,March 2010*.

16. S.Sinha, M. Saini, and B. K Kanungo**,"**Effects of various additives on mechanical properties of rice huskpolypropylene(RHPP) composites" *Polymer Engineering*,vol. 32(3), pp.163-33, 2012

.

17. V. Fabrizio Sarasini, F. Marra, J. Tirillò,and G.Pulci,,."Recycled glass fiber/wood flour thermoplastic composites: Manufacturing and mechanical characterization",*Composites Part A: Applied Science and nufacturing, Vol. 42, pp.649-657, June 2011*.