

STUDY OF COUPLING AGENT FOR WOOD-PLASTIC COMPOSITE

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1. Introduction

Recently, as quality of life has improved, demand of eco-friendly and high performance material increases. So usage of WPC, wood plastic composite, noticeably increases in construction, interior and exterior materials.

WPC has several advantage compared with natural wood and plastic. WPC is eco-friendly because it is recyclable and waste wood and plastic resin can be used as raw material. And, chemical treatment which is toxic was usually used for preventing bio-degradation. But WPC is not toxic because it is not containing TVOCs. And WPC is not bio-degradable so it is semi-permanent. Mechanical properties like durability are greater than conventional wood material. [1]

Various design is also benefit of WPC. In case of typical wood materials, only carving is available. But WPC can be extruded, and injected, so design of product is various.



Fig. 1 Application of WPC

But WPC also has several disadvantages. WPC can be only used in deck, handrail and finishing materials because of dimensional stability and impact strength. And Polyethylene (PE) and Polyvinylchloride (PVC) are usually used as plastic resin in WPC. But PE has bad thermal stability and PVC has good mechanical properties but contains harmful substances like plasticizer.

Generally, plastic, especially polyolefin, is hydrophobic, on the other hand cellulose, main composition of wood, is hydrophilic. So they are not compatible, compatibilizer or coupling agent is essential. Coupling agent was composed of polymer backbone and polar functional group like acrylate, maleic anhydride. [2]

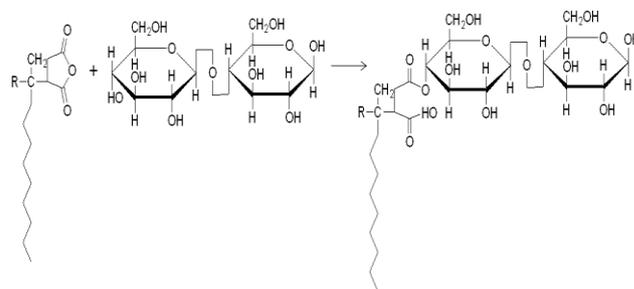


Fig. 2 Mechanism of coupling between maleic anhydride and cellulose

In this study, two type of coupling agent was produced by reactive extrusion. One type is maleic anhydride type and other one is glycidyl methacrylate. And WPC sample using polypropylene was made by internal mixer. The product was characterized by FT-IR, SEM, Instron tensile tester. As a result, the mechanical properties of WPC with coupling agent were enhanced

compared with those of WPC without coupling agent. So, the effect of coupling agent was confirmed.

2. Material and experimental

2.1 Material

Used reagents are as follows.

- Homo-Polypropylene from Honam Petrochem..
- Ethylene-methylacrylate copolymer from DuPont
- Maleic Anhydride from Yongsan Chemicals, INC.
- Glycidyl methacrylate from Dow chemical.
- 2,5-dimethyl 2,5-di(terthiobutylperoxy) hexane (Peroxide) dispersed in Polypropylene base resin made by Polytechs

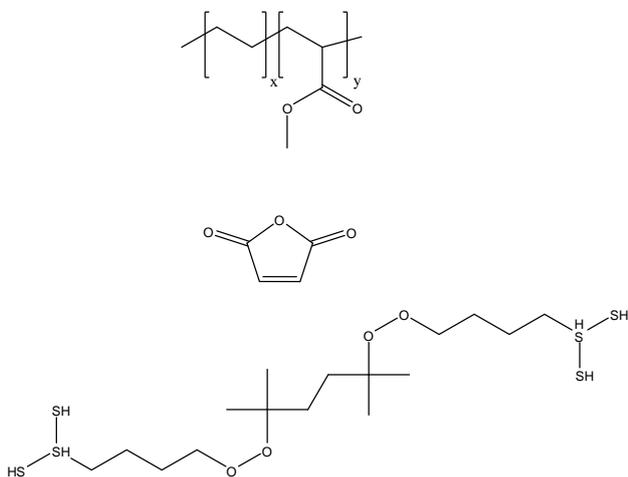


Fig. 3 Chemical structure of ethylene-methyl acrylate copolymer, maleic anhydride and 2,5-dimethyl 2,5-di(terthiobutylperoxy) hexane(Peroxide)

2.2 Experimental

2.2.1. Coupling agent

Coupling agent was made by reactive extrusion in internal mixer, Brabender Plasticoder W50E Mixer.

Homo-PP and peroxide, maleic anhydride reacted at 200°C and 100rpm.

Ethylene-Methyl Acrylate and peroxide, glycidyl anhydride reacted at 180°C and 100rpm.

2.2.2. WPC

Wood flour, homo-PP and coupling agent which is prepared in 2.2.1 were compounding performed by internal mixer. The mixing temperature was 170°C, RPM was 100min⁻¹.

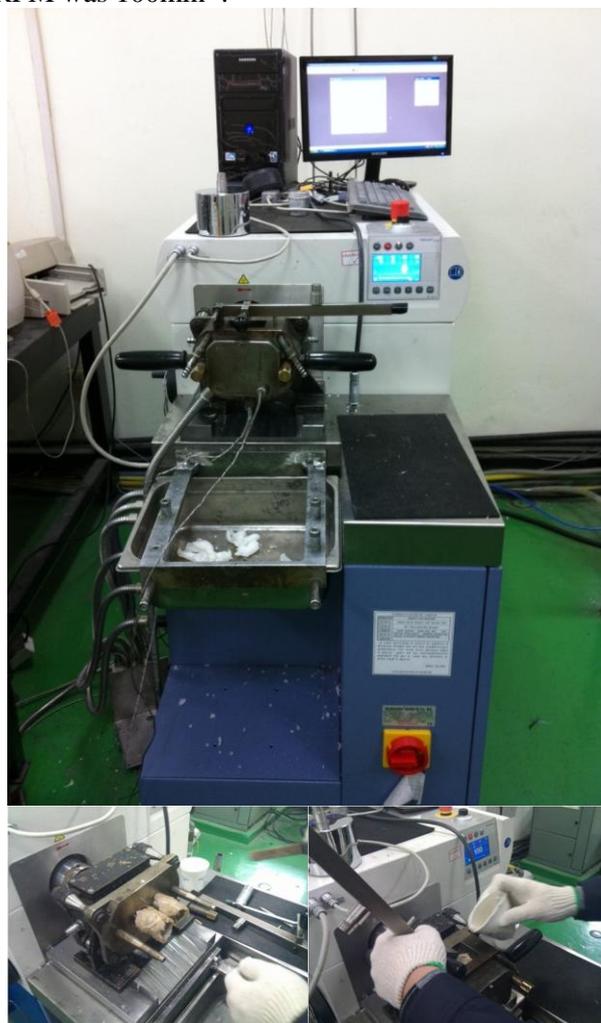


Fig. 4 Mixing experiment by internal mixer

3. Results and Discussion

3.1. Coupling agent

Maleic anhydride graft ratio was measured by FT-IR using 1780cm⁻¹ peak by carbonyl functional group of maleic anhydride and the value is 1.3wt%. [3]

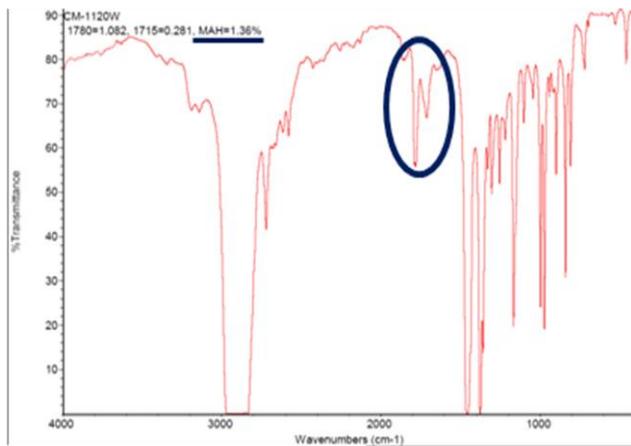


Fig. 5 FT-IR for quantitative analysis of maleic anhydride

Glycidyl methacrylate graft ratio was also measured by FT-IR using three peak(of epoxy functional group and the ratio is 5~15%.[4]

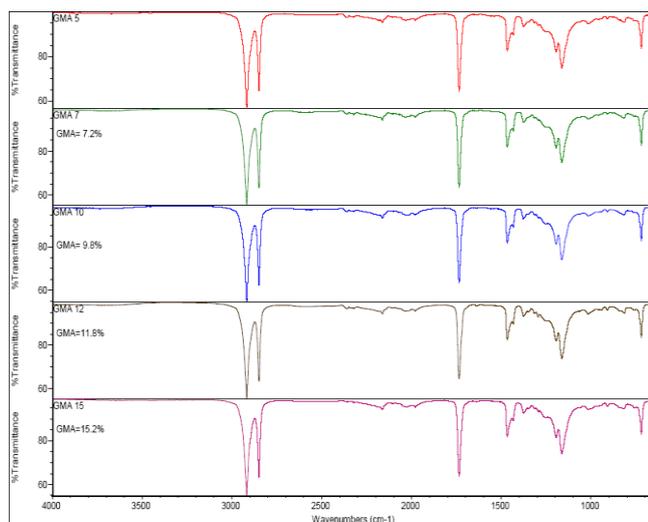


Fig. 6 FT-IR for quantitative analysis of glycidyl methacrylate

3.2. WPC

3.2.1. Mechanical properties

Test sample was made by hot press machine. After that, using universal test machine (UTM), flexural modulus and strength were characterized. The

mechanical properties are enhanced compared with natural wood and WPC without compatiblizer.

3.2.2 SEM

Fig. 7 is SEM picture of WPC without coupling agent and Fig 8. is SEM picture of WPC with coupling agent PP-g-MAH. The pictures show many voids compared with WPC with coupling agent. So WPC with coupling agent has better mechanical properties such as flexural modulus than that without coupling agent.

In case of impact strength, that of WPC with coupling agent decreases compared with that of WPC without coupling agent. Between wood fiber and resin, interaction force of WPC without coupling agent is small. When WPC is impacted, wood fiber slip through resin, impact is absorbed.

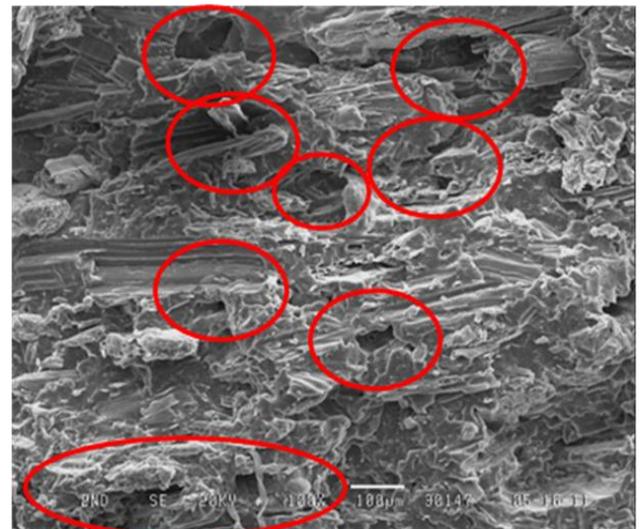


Fig. 7 WPC without coupling agent and voids in red ellipse

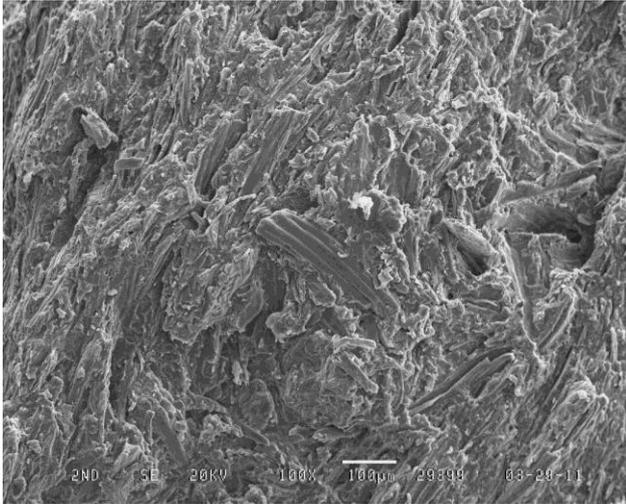


Fig. 8 WPC with coupling agent (PP-g-MAH) 3wt%

4. Conclusion

Coupling agents, PP-g-MAH were synthesized. And WPCs with the coupling agents have good mechanical properties compared with WPC without coupling agent except impact strength.

GMA type coupling agent was synthesized but it is not used for WPC in this study. It will be compounded and characterized next experiment.

4. References

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