CHAPTER V

CONCLUSIONS

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5.1.1 In the factorial design, the main finding is that the mechanical properties are significantly effected by order untreated $CaCO_3$, treated $CaCO_3$, untreated talc, treated talc and carbon black. The thermal properties are not significantly effected by the five factors and their interactions.

5.1.2. In the mixing study of the mineral fillers and HDPE, the mixing torque increases with the filler content. The incorporation of the titanate coupling agent can decrease the mixing torque in the mix systems.

5.1.3. The tensile properties of the $CaCO_3$-filled HDPE in terms of the modulus of elasticity, the yield stress and the stress at break are all enhanced with the $CaCO_3$ content. The properties in term of the yield strain, the maximum stress and the fracture energy, however, tend to decrease when more $CaCO_3$ is applied. The incorporation of the titanate coupling agent can effectively enhance the yield strain and the fracture energy. As a consequence, the modulus of elasticity and the yield stress are reduced.

5.1.4. The compression properties of the $CaCO_3$-filled HDPE in term of the compressive modulus and the yield stress increase with the $CaCO_3$ content. The incorporation of the titanate coupling agent can increase yield strain but decrease the modulus and the yield stress.

5.1.5. The hardness of the $CaCO_3$-filled HDPE increases with the increases $CaCO_3$ content, because the CaCO3 is higher hardness than HDPE matrix. The incorporation of the titanate coupling agent does not change the hardness.

5.1.6. The Izod impact strength of the $CaCO_3$-filled HDPE decreases with the $CaCO_3$ content. The incorporation of the titanate coupling agent increase Izod impact strength, because the better addition between the $CaCO_3$ particles and the HDPE matrix.

5.1.7. In the falling weight study, the absorption impact energy and the falling impact cracking deformation of the $CaCO_3$-filled HDPE decreases as one increases the $CaCO_3$ content. The incorporation of the titanate coupling agent can effectively increase the absorption impact energy and the falling weight impact cracking deformation, because the better addition between the $CaCO_3$ particles and the HDPE matrix.

5.1.8. The thermal properties analyzed by the differential scanning calorimeter and the dynamic mechanical thermal analyzer show that the addition of $CaCO_3$ and the titanate coupling agent do not have significant effect on the melting temperature, the percent of crystallinity and the glass transition temperature of filled HDPE.

5.1.9. The heat deflection temperature of the $CaCO_3$-filled HDPE increases with the $CaCO_3$ content. The incorporation of the titanate coupling agent decreases the heat deflection temperature, because the $CaCO_3$ content has a tendency to increase the modulus and the restriction to mobility of the HDPE chains.

5.1.10. The density study of the $CaCO_3$-filled HDPE increases with the $CaCO_3$ content, because the $CaCO_3$ is higher density than the HDPE matrix.

5.1.11. The cryogenically fractured morphology of the $CaCO_3$-filled HDPE shows that there is good particle distribution for both systems with and without titanate coupling agent. This is because the twin screw extruder is a highly efficient compounding machine. The incorporation of the titanate coupling agent can improve the bonding between the interface of the $CaCO_3$ and the HDPE matrix. This is verified by the microscopic observation of the fracture surface of the titanate treated systems.

5.1.12. Suitable $CaCO_3$ content is in the range of 10 to 20 phr which yields a system that still exhibits some ductility. The titanate coupling agent is best applied at 0.5 %.

Recommendation for Further Study

1. Other types of titanate coupling agents can be applied to compare their effects on the HDPE-filled systems in order to yield other prospect from titanate species.

2. The present study can be extended to investigate how the crystallization temperature and the filler affect the crystallization of HDPE.