

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATION

#### 5.1 Conclusions

The graft copolymers of HDPE and MAH had been successfully prepared in a molten state by mechanical shear rates and thermal initiation in the presence of DCP initiator. Quantification of the grafted MAH on the HDPE was performed by considering the level of carboxylic acid from the hydrolysis of anhydride group in MAH as determined by titration with standard KOH solution in ethanol. An MAH addition of 2 phr yielded the highest grafting yield of 1.5% onto HDPE chains. FT-IR spectra confirmed that MAH was successfully grafted onto HDPE chains.

ABS and HDPE are the incompatible blend. The HDPE-g-MAH can be used to solve the problem of incompatibility of ABS/HDPE blends. The role of HDPE-g-MAH are found, in this research, as an interfacial agent and impact modifier to provide the better interfacial adhesion between ABS and HDPE by enhancing the depression of the minor phase droplets, hindering coalescence and reducing interfacial tension.

The compatibilizing effect in the industrial applications of ABS/HDPE blends by HDPE-g-MAH on the mechanical properties was found. The impact strength, tensile strength and elongation at break of the blends were improved by using the HDPE-g-MAH as compatibilizers. The impact strength of the blends sharply increased when HDPE was the continuous phase. The addition of 2 phr loading of

HDPE-g-MAH compatibilizer could not improve the flexural strength. One has to keep in mind that, for a specific property required in the blends, ABS/HDPE blend increases impact strength and tensile strength at the expense of reduced flexural strength.

On evaluation of compatibility, the log additivity rule model is applied to the shear viscosity data from the capillary rheometer for compatibility study of ABS/HDPE blends by HDPE-g-MAH. The positive deviation behavior was observed at high shear rates for the ABS-rich phase and at high shear rates for the HDPE-rich phase. The pseudoplastic behavior (shear-thinning) was observed for every blend ratio. Morphology of the blends was improved by addition of HDPE-g-MAH. The HDPE-g-MAH could reduce the size of the dispersed phase particles, which produced more uniform dispersions and finer particles to form the co-continuous phase of the blends. The extent of phase compatibility depends on the blend condition i.e. blend composition, viscosity ratio of blends, mixing time, and compatibilizer loading. Glass transition temperature and melting temperature from DSC measurement were close to those of the base resin. Such results implied some miscibility at the molecular level of some blend ratios compatibilized by HDPE-g-MAH. Nevertheless, the interfacial adhesion between two phases was improved as evidenced by the mechanical properties. The weathering test was also examined by monitoring the yellowness shifts ( $\Delta E$ ). The  $\Delta E$  value of all blend ratios decreased when increased the HDPE contents. It can be explained that the HDPE has a greater proportion of crystalline regions; the size and size distribution of crystalline regions are determinants of environment resistance. We could then conclude that the HDPE-g-MAH provides better interfacial adhesion between the two phases.

## 5.2 Recommendation for the future work

1. To recheck the thermal properties of the blends containing HDPE which owns a very weak  $T_g$ , the DSC equipment should have two furnaces with a build-in configuration to allow very fast controlled linear heating and cooling scanning to  $750 \text{ K min}^{-1}$ . With the more precise  $T_g$  values of the neat polymers and the blends, an accurate evaluation of blend compatibility by the compatibilizer shall be realized. Another route to characterize the  $T_g$  of HDPE is to use the technique of dynamic mechanical analysis (DMA) in which  $T_g$  of the HDPE phase can be better observed.

2. The questional causes of thermal oxidative degradation during graft copolymerization of MAH on HDPE must be cleared. Modification of the extruder by equipping an inert gas flowing unit throughout the reactive grafting is essential. Better results can be acquired together with characterization of HDPE-g-MAH in terms of grafting yield and chemical composition.

3. From the result of this study, the ABS/HDPE blends by HDPE-g-MAH as compatibilizers can be applied for a pilot production scale of the ABS alloys that are used in outdoors applications. However, more experiments are needed.

4. The amount of the HDPE-g-MAH compatibilizer used in the blends should be increased to 5 to 10 phr.

5. Shear rate and elongational stress should be increased during blend compounding.