

CHAPTER II

LITERATURE SURVEY

2.1 Blending of Nylon and LDPE

The study about polymer blending has been the subject of much interest. There were a lot of research carried out to study about polymer blending in both compatible and incompatible blending. LDPE and nylon blending is one of the most interesting area of research. Many studies have been carried out in this field or the area close to this field. Some of them are still being studying.

The incorporation of nylon barrier material into polyolefin material was studied by *P.M. Subramanian* (1985). The high permeability of hydrocarbon chlorinated solvents and vapors can pass through the polyolefin films. Nylon, as a layer of a resistant polymer next to that more permeable polymer, was introduced into that lower cost matrix material. It could be processed in a single step operation. The compatibility can be improved by incorporating a surfactant or compatibilizer or interfacial agent or modified nylon. For transport properties such as permeability, the optimum permeability barrier properties are obtained at 18 percent of nylon component and modest to good permeability barrier properties are obtained at concentrations of 5 to 10 percent of nylon component. In morphology studying of this system as a function of the size and shape of the nylon particles, it was discovered that when processed in an extruder system under controlled processing conditions where the melted nylon particles are prevented from becoming tiny droplets, afford quite different permeability properties.

The effects of composition and resulting morphology on rheology of blends of polyethylene and nylon 12 were studied by *J. Huitric et al.* (1997). Two immiscible polymers having the same Newtonian viscosity but different

elasticity, were studied in the whole range of volume fraction. In immiscible blend, the blend properties depend on constituent polymers, on the heterogeneous morphology formed during the processing, and on agents often added to blends of homopolymers to enhance the compatibility. The final morphology was determined by the level of local stresses encountered in the mixing of polymers, the blend composition, the interfacial tension and the viscoelastic properties of the components. They chose polyethylene and nylon 12 sample to provide optimum accuracy in the measurements of rheological parameters of interest in this work. They studied the rheological characterization of pure polymer using rheometric dynamic analyser (RDA II), blend morphology using a scanning electron microscope (SEM). The rheological behavior is related strongly to this morphology. In this project, the researchers studied both the influence of the dispersed phase and its morphology on the rheological properties of the blend. The measurements were steady shear viscosity, dynamic viscosity, the steady normal stress difference over entire range, from zero to one, of volume fraction of disperse phase. In blend morphology, they observed both in fibrillar morphology (for PE/PA12 = 50/50) and nodular morphology (made of polyethylene for PE/PA12 = 20/80) (made of polyamide for PE/PA12 = 70/30). However, two difference nodular morphologies are observed when comparing the two regions: first PE nodules are more bulky than PA12 nodules for the same volume fraction: and second polyamide region is less extensive than polyethylene region. They concluded that these two results can be related to the relative elasticity of the constituents.

The morphology of compatilized polyolefin /polyamide blends was found by *J.M. Willis and B. D. Favis* (1988) to be significant dependent on the concentration of the ionomer compatibilizer (polyethylene-methalacrylic acid-isobutyl acrylate terpolymer) in the blend. For the dispersed phase content of 10% by weight, a maximum reduction in phase size was observed

when only 0.5% by weight of ionomer was added to the blend. A more significant reduction of the dispersed phase size was observed when the minor phase was nylon, due to the interactions exist between ionomer and polyamide. At high concentration of the ionomer, flocculation of the nylon dispersed phase was observed.

Soonho Lim et al. (1994) studied the influence of addition of a compatibilizing agent on a phase morphology development in a 75/25 polyethylene (PE)/polyamide 6 (PA 6) blend in a Modular co-rotating twin screw extruder. PE/PA 6 mixes with relative difficulty because large interfacial tension between the phases. They observed that the addition of compatibilizing agent produces a finer final phase morphology, causes the phase morphology scale to be reduced more rapidly along the length of the screw. The increasing amounts of compatibilizing agent both increases the rate of decrease of phase morphology size and decreases the scale of the ultimate morphology. By calculation number and weight average domain size and by visualization from scanning electron microscopy (SEM) results, show that the compatibilizer has an important role to show an acceleration of the rate of reduction of the domain size by associating to the interface of two polymers. The molten polymer which is high viscosity preventing the compatibilizer reaching the interface except by the convective motion.

Blends of nylon 6 and very low density polyethylene (VLDPE) have been studied by *Gadekar Rupali et al.* (1998). The mechanical properties were found to loss in tensile and impact strength due to poor adhesion at the interface in uncompatibilized blends. In compatibilized blends, they observed the compatibilization, which is the result from the possible reaction between reactive groups in nylon 6 and the compatibilizer through copolymer formation. The mechanical properties of the compatibilized blends were improved due to the better stress transfer across the interface. The water absorption were found decreased while the nylon 6 content decreased due to

the amide groups in the water-accessible region. They suggested that three water molecules are sorbed by two neighboring amide groups that form a sorption center.

2.2 Ionomer

There were a lot of research carried out on ionomer, which were related for this study. Many work have been studied in the area of rheology and the spectroscopy.

R. Vankan et al. (1996) studied about how rheology of the $m \times D,6$ polyamide is modified by small amounts (up to 5 wt%) of free radical initiated copolymers of methyl methacrylate and methacrylic acid, P(MMA-co-MAA) and the related ionomers, P(MMA-co-metal MA). Compared with widely used ethylene and styrene-based ionomers, the chain flexibility of methyl methacrylate-based ionomers is expected to be lower. Being more polar than polyethylene and polystyrene, poly(methyl methacrylate) could interact with the $m \times D,6$ polyamide by dipole-dipole interaction. The copolymers have been melt blended with polyamide. At low shear rates and depending of the metal ion of the cation of the ionomer, the rheofluidity of polyamide at 260°C can be dramatically reduced. In the case of complete immiscibility and complete miscibility, the rheological effect of the additive is quite negligible. Hydrogen bonding and long chain branching of polyamide amino end groups onto carboxylic acid pendant groups of the P(MMA-co-MAA) copolymers as well as ion-dipole interactions between polyamide and the ionomers are at the origin of the compatibilization effect.

Yi Feng et al. (1996) studied the result of spectroscopy on the blend of ionomer. Electron paramagnetic resonance (EPR) spectra provided information on the local environment of the metal cation in the Cu^{2+} salt of the neat ionomer, and the change that occur upon blending the ionomer with the

polyamide. Fourier transform infrared spectroscopy (FTIR) characterized the interactions of the sulfonate anion and the amide carbonyl group. Solid state ^{15}N nuclear magnetic resonance (^{15}N -NMR) considered the effect of blending on the amide nitrogen. Spectroscopies were used to characterize the structure and relative strength of the interaction between metal sulfonate and amide groups in blends of lightly sulfonated polystyrene ionomers and an N-methylated polyamide to eliminated hydrogen bonding competition reaction, poly (N,N'-dimethylethylene sebacamide), and low molecular weight model complexes. By the spectroscopic results, there are several conclusions. Firstly, the ionic aggregates are usually observed in ionomers, due to the association of the ionic groups are solvated by the polyamide by the formation of an intermolecular complex involving the metal cation of the ionomer and the amide group. Secondly, the ionomer-polyamide complex involves coordination of the oxygen of the amide carbonyl group with the metal cation. The cation used and the strength of the complex decreases with decreasing electron-withdrawing power of the cation in the order $\text{Zn}^{2+} \approx \text{Cu}^{2+} > \text{Mn}^{2+} \geq \text{Cd}^{2+} > \text{Li}^+$, which are consistent with electrostatic field theory. Thirdly, although the ion-amide coordination occurs through the carbonyl oxygen, the amide nitrogen also participates in the complex. Lastly, Zn^{2+} appears to coordinate with two amide groups, and the numbers of oxygen and nitrogen atoms involved in the complex are equal.

Brian B. Grady et al. (1998) studied the zinc-neutralized Surlyn[®], ethylene-methacrylic acid (E-MAA)ionomers, by using X-ray Absorption Spectroscopy. There are two different processes to neutralize the Surlyn[®] ionomers, solution neutralization process which often employed in the laboratory, and melt neutralization process which used to produce Surlyn[®] ionomers. The commercial E-MAA ionomers are typically not stoichiometrically neutralized with a metal ion. The effected groups on the internal aggregate structure is not well documented. The neutralized Surlyn[®] is

examined the atomic scale internal structure of aggregates. In order to quantify the local environment around the zinc atom in dry ionomers, the x-ray absorption spectroscopy (XAS) spectra is used to measure the different zinc carboxylated ionomers. In this research, the effect of neutralization procedure on the cation local structure in zinc E-MAA ionomers and the effect of methacrylic acid comonomer content and the presence or absence of unneutralized acid groups were examined.

2.3 Objectives

- To determine how addition of Surlyn[®] affects blends of nylon 6/LDPE.
- To study the morphology, physical and mechanical properties of nylon 6/LDPE blends with Surlyn[®] as compatibilizer.