

CHAPTER II

LITERATURE SURVEY

Choudhury *et al.*, (1990) studied the fracture surface morphology of various thermoplastic rubber and rubber vulcanizates based on natural rubber (NR), ethylene propylene diene rubber (EPDM), nitrile rubber (NBR), polyethylene (PE) and polypropylene (PP), namely NR-PE, NR-PP, EPDM-PE, EPDM-PP and NBR-PP as a function of blend ratios 70/30 and 30/70 rubber to plastic ratios, levels of interaction, rates, temperatures and modes of testing. The different blend ratios resulted changing fracture surface. Addition of a third component like EPDM or chlorinated polyethylene (CPE) to a certain percentage did not change the fracture morphology. Sulfur curing in the NR-PE blend produced more ductile matrix than peroxide curing systems. The surface morphology was changed with modification of both rubber and plastic. A few flow lines, small holes and a few cracks were observed. At various temperatures, rates and modes of testing showed similar features on the fracture surface.

Qin *et al.*, (1990) studied mechanical properties, structure, and morphology of NR/LDPE blends prepared by different processing methods. Blends were prepared by unvulcanized and static or dynamic vulcanizations. Morphology for unvulcanized NR/LDPE blends showed phase inversion occurring between NR/LDPE: 40/60 to 60/40, but for dynamically vulcanized blends LDPE remained a continuous phase even NR/LDPE 70/30. Mechanical properties of dynamically vulcanized blends were higher than those of unvulcanized blends but lower than those of statically vulcanized blends. Some physical properties such as tear strength, 300% modulus, hardness and permanent set were mainly dependent on the

properties of plastic phase. These properties increased with increasing LDPE in different processing methods.

Lee and Moet (1993) studied fatigue behavior of NR and BR blend. They measured the energy release rates, which related fatigue crack propagation from the load-displacement curves. At an initial state crack occurred slowly because of ozone attack. Then crack propagated quickly due to the mechanical rupture and the oxidative effect. The fracture surface and fracture profile showed microcracks and crack tip roughening which were two mechanisms controlling crack propagation.

Gent and Wang (1993) studied the cutting resistance of polyethylene. They used cutting apparatus to cut along the centerline. The total energy G_c , expended in cutting and tearing. Fracture energies from this technique were smaller than from simple tearing corresponding reduction in plastic yielding. Cutting resistance decreased with increasing temperature and orienting direction, while they were proportional to yield stress. From values of G_c and work-to-break in tension U_b , the effective diameter of the crack tip (plastic zone) was many times larger than the blade tip radius or one to three spherulite diameter. In all cases, most of G_c for polyethylene was expended in plastic yielding.

The mechanical properties of blends of γ -irradiated and unirradiated low density polyethylene (LDPE) and polyamide 6 were made by Valenza *et al.*, (1993). They studied the effects of the modifications induced by this irradiation on the final properties. Blends of LDPE irradiate at low dose rate and 25% of polyethylene showed some improvement in tensile properties but blends of LDPE irradiated at high dose rate showed a drastic decrease in the same properties. These results indicated the different effects of γ -radiation in LDPE. Functional groups were formed in the LDPE irradiated at low dose tare, while a minor amount of functional groups and gel were observed in the LDPE irradiated at high dose rate. Functional groups gave

rise interaction with polyamide. These modification affected impact properties, which were much higher than those of unirradiated LDPE blends.

Machado (1994) studied the compatibilization of immiscible blends. There were four immiscible blend systems: styrene-maleic anhydride/styrene-acrylonitrile (SMA/SAN), styrene-maleic anhydride/acrylonitrile-butadiene-styrene (SMA/ABS), poly(vinylidene fluoride)/SAN (PVF2/SAN), and PVF2/ABS. The effect of adding up to 1% wt of a third polymer that is miscible with each blend component, PMMA, was determined. The addition of PMMA brought to the improvement of mechanical properties such as tensile strength, elongation, and notched impact strength. Moreover, the addition of PMMA resulted in finer and more uniform dispersions of the primary blend components.

The impact properties of the thermoplastic composites containing ground rubber tires (GRT) had been investigated by Pramanik *et al.*, (1995). LLDPE was used as the polymer matrix. Adding different compatibilizer or modified GRT were the methods to improve impact strength. The use of epoxidized natural rubber (ENR) and ethylene-co-acrylic acid (EAA) compatibilizer system improved the impact properties depending on the composition of the composites. Increasing ENR content, the impact energies or ductilities of some composites increased. The dicumyl peroxide (DCP)/maleic anhydride (MA) system showed a great increase in impact strength with an increase in the melt viscosity of the composites. The coating of GRT with curing and co-curing agents showed a moderate increase in impact properties. There are three mechanisms to improve impact strength: improved interfacial adhesion, elastomer toughening of the matrix phased, and matrix phase crosslinking.

Axtell *et al.*, (1996) investigated the effect of modified NR compatibilizers on polyamide 6/NR blends. Maleic anhydride modified NR

was used to compatibilize this blend. The blend compatibilization occurred by physical interaction and by chemical formation from *in situ* copolymers. A higher degree of dispersion of rubber was a result of addition of the compatibilizer. The presence of the smaller rubber particles gave greater toughness to the blends and improved mechanical properties such as Charpy impact strength, tensile strength and elongation at break.

Kitao (1997) used Charpy impact test to study the brittle-ductile transition temperatures (BDTT) of different degree of crystallinity polyethylene such as LDPE, LLDPE, MDPE, and HDPE. He investigated the effect of cooling plate temperatures, T_p on the BDTT. When T_p was increased for MDPE and HDPE, BDTT fell but Charpy impact value, E_t increased. For tensile test of HDPE a rise in T_p brought an embrittlement and a reduction in strength. The rise in T_p enhanced crystallization and molecular entanglement loss. These evidences promoted a crack shielding effect by microvoid formation, which increased impact strength.

Cigana *et al.*, (1997) used two triblock copolymers of styrene/ethylene-butylene/styrene (SEBS) to compatibilize a blend of 80% volume polystyrene (PS) and 20% volume ethylene-propylene rubber (EPR). They used Charpy and Izod impact test to determine the effect of the compatibilization, which related morphology. They found that for the lower molecular weight interfacial agent, a transition from brittle to ductile, occurred around 20% interfacial agent (based on the volume of the minor phase). It was not observed with the high molecular weight interfacial agent.

Tanrattanakul *et al.*, (1997) studied fracture mechanisms of poly (ethylene terephthalate) (PET) and blends with styrene-butadiene-styrene (SEBS) elastomers. The SEBS elastomers were functionalized with 0-4.5 wt% maleic anhydride graft on the midblock. All the functionalized SEBS elastomers effectively increased the toughness of PET. From fractography indicated that PET and the blend with unfunctionalized SEBS fractured

through crazing with brittle manner. Blending with a functionalized SEBS caused the fracture mechanism to change from crazing to ductile yielding. PET hydroxyl end groups reacted with the anhydride resulting graft copolymer formation which thought to act as an emulsifier to decrease particle size and improve adhesion. These factors introduced cavitation, which relieved the triaxiality at the notch root and enhanced shear yielding.