



CHAPTER I INTRODUCTION

Polymer blend is a mixture of at least two polymers. It is a low-cost way to develop novel materials. Typically, polymer blend is immiscible blend, which displays very poor mechanical properties due to weak adhesion. Process to modify interfacial properties of an immiscible blend, compatibilization, has been used to solve this problem (Axtell *et al.*, 1996). Reactive blending is an alternative way of compatibilization. It can occur in many ways, for example, formation of *in situ* graft or block copolymers by chemical bonding reactions between reactive groups of components, etc (Flokes *et al.*, 1993).

It has been known that the compatibilizer reduces the interfacial tension, permits a finer dispersion, stabilizes morphology, and enhances interfacial adhesion. One way of considering interfacial adhesion is destructive test method or deformation test method. If the blend has strong cohesion and interfacial adhesion, the fracture is difficult to occur. The strength of material depends on types of material, shape/size of the test specimen, loading (test method), and testing conditions e.g. temperature and speed (Takaki *et al.*, 1994). Most generally fracture is caused by direct loading in different system of force, for example, tensile, bending, etc. It is interesting to study fracture behavior from different test modes. In this work the fracture behavior of the LLDPE/NR blends by *in situ* reaction have been studied varied with mechanical force and time, e.g., impact, tear, creep, and tensile test and the effect of weathering to the blends.

1.1 Background

1.1.1 Fracture

Fracture refers to the separation within an object. It is defined both as rupture of the surface with and without complete separation of a body because of external or internal forces (Rosato, 1993). Mechanical failure is conducted from the applied external forces, which lead the materials to deform, crack or break into pieces. The loads may be applied in tension, compression, bending, and impact for a short or a long period of time. In addition to force, environment is an important factor. When materials expose to outdoor environments, they serve some effects from a loss of color, slight crazing and cracking, to a complete break down of a polymer structure (Shah, 1984).

The fracture resistance of a polymer depends on the material mechanical properties (elasticity, plasticity, and viscoelasticity) and the microstructure (Alger, 1989).

1.1.2 Mechanical failure

1.1.2.1 Impact

Impact tests are high-speed fracture test. The test measures the energy to break a specimen. The impact properties of the polymeric materials are directly related to toughness, which is defined as the ability of the polymers to absorb energy. The higher impact strength of a material, the higher toughness is. The factors affect the impact strength such as rate of loading, temperature, orientation, processing conditions and types, degree of crystalline, and method of loading (Shah, 1984).

1.1.2.2 Tearing

Tear test is the determination of the force to propagate a tear in plastic film and thin sheeting. This test is generally tensile test made on sheets or films which have a cut or a notch (Nielsen, 1994). The specimens may be trouser tear test pieces in which the two trouser legs are held in the two jaws of the testing machine as shown in Figure 1.1. The maximum force is recorded and divided by the film or sheet thickness to give the tear resistance (Brown, 1988).

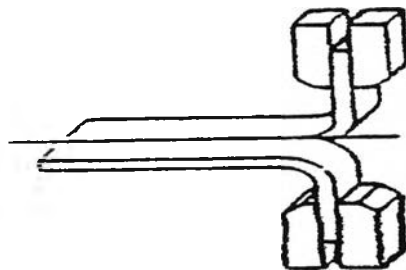


Figure 1.1 Positioning of tear test piece in testing machine.

1.1.2.3 Creep

Polymers generally exhibit time dependent deformation under constant loads, i.e., creep (Kenner, 1986). When polymers are loaded to load level less than tensile strength for brittle polymers or yield strength for ductile polymer, strain increase. If the material breaking occurs, it is called creep rupture. Creep and creep rupture are affected by factors such as applied stress level, temperature, and environment (air, water, humidity, and solvents, etc.) (Jayaraman, 1997). Creep and creep rupture tests can be performed in tensile, compressive, and flexural test. In this work the displacements are measured as a function of time in tension mode at ambient conditions.

1.1.2.4 Fatigue

Fatigue is the phenomenon of failure or fracture of materials under repeated or oscillatory loading at stress level much lower than monotonic loading (Kinloch, 1983). There are many kinds of fatigue tester such as tensile or flexural tests at constant deformation or constant stress, and bending instruments. Generally fatigue failure causes by the progressive growth of cracks. Fracture mechanics determine the rate of crack propagation in term of the local stress at the crack tip, which is expressed by a stress intensity factor, K as shown in equation 1.4.

$$K = Y\delta\sqrt{a} \quad (1.1)$$

where Y is numerical factor that depends only on the geometry of the specimen and ratio of crack length/width, δ is externally applied stress, and a is crack length. The rate of crack growth per cycle of loading is then given by

$$\frac{da}{dN} = A\Delta K^m \quad (1.2)$$

where A and m are constants characteristic a given material (Nielsen, 1994).

1.1.2.5 Tension

Tensile test is a measurement of the ability of a material to withstand forces at a constant rate that tends to stretch it and to determine its extension before breaking. When the specimen elongates, its resistance increases and is detected by a load cell. Stress and strain are measured until the specimen breaks. The tensile stress and strain are defined as:

$$\text{Tensile stress} = \frac{\text{Tensile force}}{\text{Original cross - sectional area}} \quad (1.3)$$

$$\text{Strain} = \frac{\text{Change in length}}{\text{Original length (gauge length)}} \quad (1.4)$$

The relative stiffness of a material is indicated by tensile modulus (Shah, 1984) which is defined as:

$$\text{Tensile modulus} = \frac{\text{Difference in stress}}{\text{Difference in corresponding strain}} \quad (1.5)$$

1.1.3 Environmental failure

Environmental resistance is the resistance of materials to change properties as a result of exposure to some environment (Brown, 1988). UV rays, humidity, microorganisms, ozone and oxygen, heat, and pollution are the major environmental factors that seriously affect polymers.

The energy of UV radiation is strong enough to break molecular bonds, which brings about thermal oxidative degradation as shown in Figure 1.2 (Costa *et al.*, 1997). The results are embrittlement, discoloration, and the reduction in physical and electrical properties. Accelerated weathering have been used to speed up natural weathering process by exposure to an artificial light sources, for example, carbon arc lamps, xenon arc lamps, and fluorescent lamp (Shah, 1984).

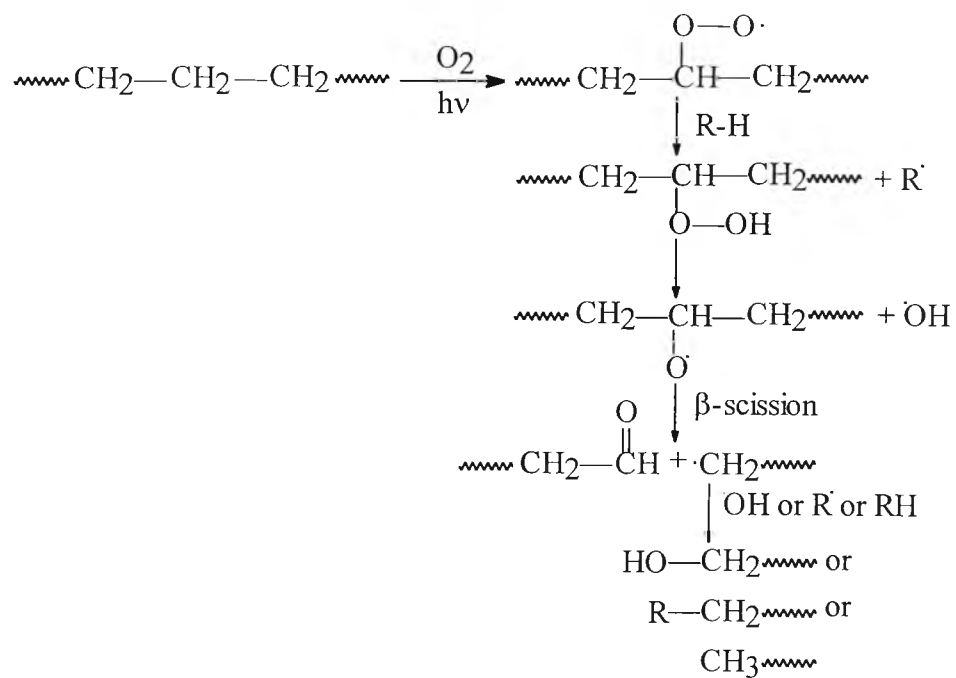


Figure 1.2 A thermo-oxidation reaction.