CHAPTER I
INTRODUCTION

1.1. Background

Low density polyethylene is a thermoplastic resin very widely used in the manufacture of film by the tubular blowing process. Resins for many types of film and sheet account for over half of the consumption.

From the practical point of view, it is highly desirable to have criteria for the choice of resins that will give good film blowability and desirable properties of blown film as well. Such a criteria, once established, will help the resin producers to tailor-made specific resin for certain applications and also, will help the tubular film producers to conduct routine test of the quality of the resin that they receive from the resin producer. However, there has been little study of this operation especially with regard to structure development and optical characteristics of films produced in the tubular blowing operation.

First of all, in the selection of a film for a particular application, the properties of the thermoplastic materials must be considered in view of the application. Obviously, primary structures of resin such as molecular characteristics, thermal properties and crystallinity of the polymer, affect processing and in turn film structure and film properties (Fig. 1.1). Molecular structure, including molecular weight (Mw), molecular weight distribution (MWD), short chain branching (SCB), short chain branching distribution (SCBD) and long chain branching (LCB), affect extrusion and orientation processes and physical properties of the film, e.g., tensile strength, elongation, impact resistance, and optical properties. Films prepared from high Mw materials exhibit high mechanical strength, impact strength, and orientability. As Mw increases, melt strength increases.

The orientation of macromolecules in fabricated and naturally occuring polymers plays an important role in determining their performance, ranging from mechanical to optical properties. Tubular orientation requires high Mw and a melt index (MI) of 0.1-3 to provide adequate melt strength during extrusion and orientation. However, high MW impedes processing and results in film with poor optical clarity, despite the high orientation. Films of lower Mw material are brittle, difficult to orient, and have lower melt strength. However, low Mw resins are characterized by good clarity and high extrusion or processing rates. At the same Mw, optical properties, draw down, and impact strength increases as MWD becomes narrower, whereas melt strength, die swell, shrinkage and processibility decrease (Mark, 1985).

Increasing crystallinity of polymer is accompanied by increase in modulus, stiffness, density, yield stress, chemical resistance, melting point, glass transition temperature, abrasion resistance, creep resistance, and dimensional stability, and by reduction in impact resistance, elongation, thermal expansion, permeability, and swelling. Final crystallinity and orientation in crystalline and amorphous phases depend strongly upon process conditions.

LDPE has a very complex molecular structure despite the fact that it consists of only one monomeric unit, i.e ethene. LDPE exhibits a broad molar mass distribution (MMD). Synthesis by a high pressure free radical process involves unique chemistry and as a result of intra- and inter-molecular chain transfer reactions, short and long chain branches exist.

Short chain branches, so call alkyl substituents cannot conveniently fit into the crystal lattice of PE. Therefore the melting point, crystallinity, and density are reduced. Typical commercial products have a degree of crystallinity of 45- 55%

and a melting point of 105-115°C, compared with 70-90% and 135°C for unbranched PE. These products contain 15-25 short chain branches per 1000 carbon atoms. Short chain branches influence the morphology and solid properties of semicrytalline polymer (Mark, 1985).

In addition to alkyl substituents, long chain branches as long as the backbone chain are formed by the grafting of polymer chains before they can be removed from the reactor. Such chains broaden molecular weight distribution (MWD) and have a pronounced effect on rhelogical properties.

Rheological properties play an important role in film blowing. The elastic nature of the melt at any temperature affects surface smoothness, layer thickness and stability. Solid phase rheology influences stretching. Because of the complexity of the flow involved, it is generally not possible to establish simple quantitative correlation between these phenomena and easily measured rheological properties. However, an understanding of how variation in the rheological behavior of the melts can affect the processing and properties of blown film is essential if one is to achieve optimum results from this process (John, 1990).

From the end use point of view, the clarity of film is very important for certain applications. Acquiring a better understanding of the cause of haze of LDPE blown film and improved understanding should provide a guide for modifying polymer chain structure and film fabrication conditions to achieve lower haze, and higher gloss level.

1.2.Research Objectives

This work concentrates on establishing the correlation between molecular structures such as MW, MWD, SCB, LCB of LDPE resins and the properties of resulting blown film with special emphasis on its optical and mechanical properties. Figure 1.1 shows the interrelationship between these parameters.

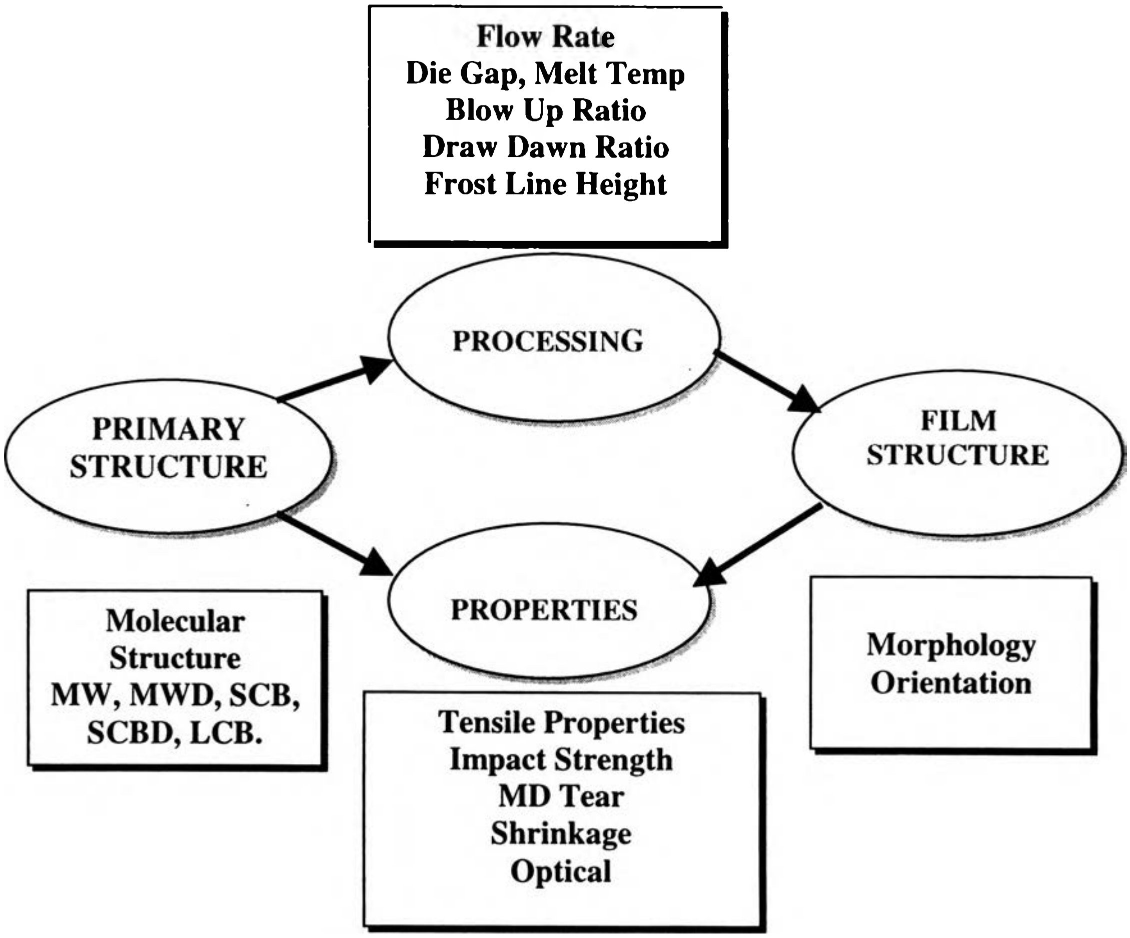

Figure 1.1 Schematic of effects of primary molecular structure and processing conditions including film structure on the properties of PE blown film.