



CHAPTER I

INTRODUCTION

1.1 General Introduction

Plastic, is a polymer, is a engineering material which influences on life today. Their resistance to corrosion and tremendous lighted weight has enabled the even to replace metals in construction of many building tools, package and many comforts. Classical polymers such as polypropylene, polyethylene and polystyrene are greatly interest for engineering and industries. These polymers are not only the most used plastics but also they show an above-average growth rate as materials.

Polystyrene (PS), is a typical rigid plastic, has been known since the last century; it was commercialized by I.G. Farben in 1931 and it is now one of the most widespread polymeric material, appreciated for its excellent stiffness and transparency and its good process ability. Its applications range from high modulus, transparent grade to rubber modified, tough resins and blends with outstanding impact resistance and new range of possibility.

Polystyrene has three forms that are atactic, isotactic and syndiotactic. The polymerization of styrene with radical initiators either bulk, in solution, in suspension or in emulsion affords atactic polystyrene (aPS). Atactic polystyrene (aPS) is an amorphous (non-crystalline) polymer with a glass transition temperature (T_g) of 100 °C. Its application at high temperature is limited and it has low solvent resistance. In 1955, Natta et al. obtained isotactic polystyrene (iPS) by using Ziegler-Natta catalytic system $TiCl_4/Al(CH_2CH_3)_3$. IPS is highly crystalline, with a melting temperature of 240°C. However, its crystallization rate is too slow to utilize as any viable commercial applications and it has not been commercialized because of it has slower rate of crystallization compared to sPS. More recently, Ishihara et al. were able to obtain syndiotactic polystyrene (sPS) [1] by using homogeneous organometallic catalytic systems based on titanium compounds (titanocene) and methylaluminoxane (MAO).

The engineering polymer especially sPS still have high viscosity, low strength [2] and require high processing [3] temperature to lower down the viscosity. However, at high processing temperature the excellent properties may deteriorate by thermal degradation. There are several processing additives to improve the processing properties at lower processing temperature such as lubricant and plasticizer, but they may cause negative effects to other important properties, especially mechanical properties of the final products.

Because of the crystals, the sPS displays entirely different properties to conventional polystyrene such as high chemical resistance, excellent environmental stress crack, heat and solvent resistance. The mechanical properties are often the most important properties because virtually service conditions and the majority of end-use applications are involved by mechanical loading. Nevertheless, these properties are the least understood by most design engineers. The sPS shares one major property with conventional polystyrene, however, namely inherent brittleness and low strength.

For all disadvantages, blending of sPS with other polymers is another strategy for improving thermal and mechanical properties at room condition.

Blending polymer is common and versatile technique to develop the ultimate properties. There are many methods to blend polymers together such as by using heat, solvent or others. The miscibility of the blends is the result of the special interactions between molecules and the appropriate molecular weights of the components. The blends can be synergistic or having better properties than either polymer pairs.

In this research, the selected polymers that have been reported to be miscible with sPS were chosen as a pair for blending. Then, all of their mechanical properties are determined.

1.2 The Objective of This Thesis

To study the effects of molecular weight of syndiotactic polystyrene (sPS) and five types of blended polymer on mechanical properties of the polymer blends by using Dynamic Mechanical Analysis (DMA).

1.3 The Scope of This Thesis

1.3.1 Choosing polymer by using Differential Scanning Calorimetry (DSC) for miscibility and Thermal Gravity Analyzer (TGA) for degradation.

There are five polymers;

Poly(*cis*-isoprene), (PIP)

Poly(*n*-butyl methacrylate), (PBMA)

Poly(ethyl methacrylate), (PEMA)

Poly(cyclohexyl methacrylate), (PHMA)

Poly(*alpha*-methyl styrene), (PaMS)

1.3.2 Blending syndiotactic polystyrene with different types of polymers using melt mixing.

1.3.3 Blending syndiotactic polystyrene of different molecular weights with selected polymers by using melt mixing.

1.3.4 Characterizing syndiotactic polystyrene blends in 1.3.2 and 1.3.3 by using Dynamic Mechanical Analysis (DMA) to find E' curve, master curve, and Williams, Landel and Ferry (WLF) constants.