CHAPTER I

INTRODUCTION

1.1 Purpose of investigation

Poly(methyl methacrylate) (PMMA) or acrylic is a thermoplastic, which is a high amorphous. The production of the acrylic sheets is carried out by bulk polymerization via casting process. Due to its advantages in terms of high clarity and safety with light weight and high resistance to outdoor environment, it is used in various applications such as aircraft window, car components, laminated glass, laminated roof, protective coating, lens, transparency roof tile, dyed interior decorated product, dental materials, optical equipment, instrument, light box, furniture, stand menu, aquarium and appliance covers, home furnishings etc (Billmeyer, 1984 and Fred, 1971). Polystyrene (PS) is also thermoplastic material, which has similar properties to PMMA (Charmondusit et al., 2009). To compare the price of methyl methacrylate (MMA) and styrene (ST) monomers in mid-May of 2010, the price of MMA was $2,250 -2,300/ton while ST was $1,250-1,300/ton (Asian market review by Clive Ong, ICIS pricing, 2010). It was also reported that the price of MMA monomer will be more expensive than that of ST as 77% per year. This will directly affect on the production cost of acrylic products. In order to decrease the cost of the acrylic sheet production, the copolymerization technique of MMA and ST has been considered. However, the resulting product exhibit the brittle property and low impact strength (Oommen et al., 1993).

There are many attempts to improve mechanical properties of brittle materials by blending with elastic polymers such as butadiene rubber, styrene-butadiene rubber (Sriprachuabwong et al., 2006), ethylene-vinyl acetate copolymer, natural rubber (Prasertpong et al., 2008) and polyurethane (Heim et al., 1993. However, these rubbers contain unsaturated C=C bonds resulting in poor thermal and oxidation stability which limit to outdoor applications. Thus, the saturated elastomers are attractive materials to use for improving the mechanical properties including oxidative and thermal stability of the brittle materials. Ethylene-propylene-diene rubber (EPDM), one of saturated rubbers, shows outstanding thermal resistance to heat, light, oxygen and ozone according to its less content of C=C bonds and non-conjugated diene component (Indian Rubber Institute, 1998). EPDM has been used as a toughen agent for non-polar polymers, such as polypropylene (PP) (Bassani and Pessan, 2002). To get satisfied toughening properties, EPDM is often grafted with vinyl and/or acryl monomers to increase its polarity to blend with plastics for preparing the high impact engineering material with excellent resistance to weatherability, yellow discoloration and aging property (Morton, 1973).

Generally, the blend of polymer with highly different polarity exhibits poor mechanical properties of final product due to incompatibility and phase separation (Bemiller, 1976). To minimize phase separation and increase interfacial adhesion, the addition of a compatibilizing agent such as a third polymer, a graft or block copolymer, could improve the interaction between the constituent polymers. It is well known that the graft copolymers promote the adhesion between the rubbery and glassy phases resulting in mechanical property improvement of the blends (Collyer, 1994). Therefore, the objective of this research was to prepare graft copolymer of MMA and ST on EPDM rubber via solution polymerization initiated by benzoyl peroxide. The modified acrylic sheets were prepared by bulk polymerization of MMA with a small amount of graft rubber and then casted in a two-glass plate mold. The mechanical,and physical properties including morphology of the modified acrylic sheets were investigated in terms of percentage of grafting efficiency and graft EPDM content. The thermal and ultraviolet (UV) resistance including kinetics of thermal degradation were also reported.

1.2 Research objectives

The objectives of this research could be summarized as follows:

1. To prepare the graft copolymer of MMA and ST on EPDM rubber at various reaction time to achieve the desired grafting level.

2. To investigate the mechanical properties and morphology of the modified acrylic sheets containing graft EPDM (GPDM) with various contents and grafting levels.
3. To study the thermal and UV stability of the modified acrylic sheets containing GEPDM with various contents and grafting levels. The kinetics of thermal degradation of the modified acrylic sheets was also reported.

1.3 Scope of investigation

In preparation of GEPDM, the effect of the reaction time of graft copolymerization step on the grafting properties was investigated. Subsequently, the GEPDM was added into the monomer mixture of MMA and ST at 80/20 wt% for preparing the modified acrylic sheets. The effect of the GEPDM content and percentage of grafting efficiency (%GE) on the mechanical and physical properties of the modified acrylic sheets was examined before and after thermal and ultraviolet ageing. The morphology of the modified acrylic sheet before ageing was also reported. The step experiments were as follows:

1. Literature survey and in-depth study of this research work.
2. Preparation of graft copolymer of MMA and ST on EPDM rubber via solution copolymerization initiated by using benzoyl peroxide.
3. Structure characterization of the GEPDM.
4. Preparation of the modified acrylic sheets containing various contents and grafting levels of GEPDM by bulk polymerization.
5. Investigation of the effect of GEPDM content and %GE of GEPDM on the mechanical and physical properties of the modified acrylic sheets before and after thermal and UV ageing.
6. Study of the kinetics of thermal degradation of the modified acrylic sheets.
7. Summary of results.