# CHAPTER I
# INTRODUCTION

Modification of polymeric materials without the development of new synthesis procedure can be categorized as the post-reactor modification. Its definition covers a wide range of operation such as polymer blending, grafting with specific side groups, and molecular structure modification i.e. crosslinking (Peacock, 2000). Although these operations have been introduced for a very long time, they still are on interest and being developed since the specific product performance can be simply prepared. The elementary operation parameters as well as the innovative technique applied for supporting the operations (In-line process) have concurrently concerned.

According to plastic industry, the modification in single-step during the product manufacturing is required as for economic reasons (Hernandez *et al.*, 2000). Hence, the reactive processing is always involved in term of both reactive blending of polyethylene with other phases and reactive modification of single-phase of polyethylene.

To initiate the reaction, the sources of active sites are in need. Major resource is via chemical routes to be added into the system. Additionally, severe condition of high shear processing can provide some radicals due to the chain-scission of subjected melts (Potiyaraj *et al.*, 2003). Currently, radicals would be expected to provide in the system using the polymer surface modification via the plasma technique which can be classified as an innovation of in-line process..

Therefore, in this contribution, the objective of this work is to utilize the plasma technique as the pre-treatment procedure for polymeric material processing. Generated radicals or further peroxides formed on the plasma-treated polymer surface to be consequently used as initiators for the reactive processing instead or in help of chemical peroxide was studied in this research. All runs were done in ambient air at atmospheric pressure in order to keep continuous air-to-air process for plasma operation and polymer processing.

The overall methodology was described in chapter III that all dealt with linear low density polyethylene (LLDPE). This resin is, somewhat, not easy to be processed due to the linear backbone with attached short alkyl groups at random intervals. In order to enhance the processability, especially to fabricate high-load thin films which are the main LLDPE markets, shear thinning behavior which is improved by a broad molecular weight distribution (MWD) or chain branching is required. The incorporation of macromolecules with broad MWD into narrow MWD LLDPE is typically done during the film fabrication; i.e. chill-roll casting and film blowing. Therefore, in chapter IV, we first focused on multi-phases processing of LLDPE as represented by blending of LLDPE and natural rubber (NR). The physical and mechanical properties of the final products implied that the processing parameters as well as the ingredient played a significant role on the product performance. Thus, an indication how complicate the effects was consequently studied in single-phase reactive processing, without the polymeric minor phase. The investigation emphasized on the feeding method of a chemical peroxide initiator to alter the molecular structures of LLDPE. In chapter V, it was examined in terms of rheological study as affected to the flow during the melt processing via capillary rheometer. Moreover, the experimental factorial design and linear regression analysis was performed in chapter VI to statistically examine the effects of assigned variables.

According to the energetic species required to stimulate the reaction during the processing, novel pathway of radical generation, plasma surface modification, was introduced. Two types of atmospheric pressure plasma treatment which were an Atmospheric Pressure Plasma Jet (APPJ) and a Dielectric Barrier Discharge (DBD) were primarily studied in chapter VII to prove this hypothesis. Prominently, the surface treatment of LLDPE using atmospheric air plasma was investigated in chapter VIII. Then, in chapter IX, plasma unit was combined to a typical extrusion process regarding to the proper in-line polymer processing. The optimal feeding method for reactive processing, as in chapter V and VI, was also applied to the plasma-assisted continuous reactive processing system. The effects of reactive processing variables which were quantity of peroxide in the case of ordinary reactive processing and applied voltage as an external plasma process parameter in the case of plasma reactive processing were investigated. The rheological properties of polymer modified by shear modification, plasma modification, peroxide modification, and combination of plasma and peroxide modification were concerned using capillary rheometer. Furthermore, film product characterizations in terms of tensile strength, and oxygen permeability were carried out. In order to scope the research linkage, the flow of ideas is then illustrated in Figure 1.1. The overall conclusions and recommendations are then summarized in Chapter X.

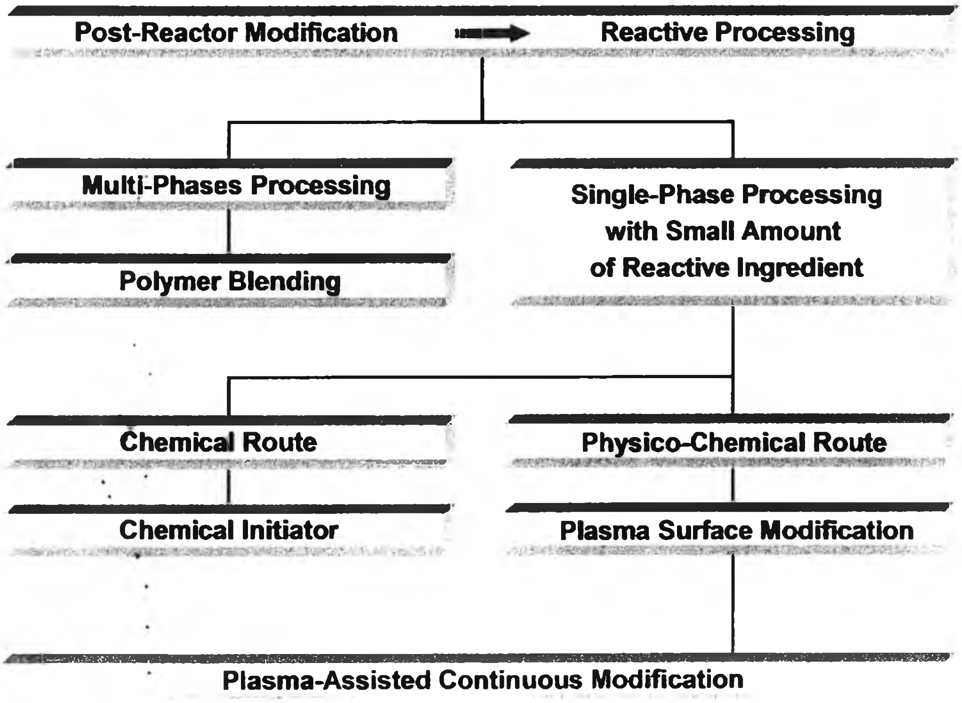


**Figure 1.1** Step work throughout the contribution.