CHAPTER I

INTRODUCTION

In the recent years, rubber wastes become one of the serious environmental problems. Because of its sulfur-crosslinked, rubber resists sliding and deformation. This material degrades very slowly and can not reprocess. In addition, rubber can not be softened or recompounded by heating again due to the presence of three-dimensional chemical network. There are many methods for treatment of rubber waste products. Reclaiming or recycling is the most desirable approach to solve this problem. Reclaiming not only protects our environment but also saves our limited petroleum resource from which the raw material is originating. Devulcanization is one of the methods for recycling rubber wastes products. This method can break down cross-linking bond or the carbon-carbon linkage of the chain backbone. There are many techniques for devulcanizing rubber wastes; for example, mechanical, chemical, thermo-mechanical, cryo-mechanical, microwave, and ultrasound. In general, chemical devulcanization uses chemical reclaiming agents for reclaiming rubber wastes. These agents are typically organic disulfides and mercaptans, which are exclusively used during mechanical working at elevated temperature. The devulcanization of rubbers by microwave energy is proposed as a suitable way to recycle rubber wastes. The microwave devulcanization process is employing a controlled dose, dose rate, and temperature. This method can return rubber wastes into the same process and products. The advantages of microwave devulcanized rubber wastes are uniform, rapid and non-contact heating, quick start-up and stoping, and non-chemical technique. However, the rubber wastes must be polar in order that the microwave energy will generate the heat necessary to devulcanize the rubber. The rubber wastes that are not containing polar group, can be improved their polarity by compounding with carbon black or silicon carbide so that they can be devulcanized with microwave energy. From devulcanization process, the devulcanized rubber is, however, not ready to reprocess because its flow rate is low, which is a problem for molding and processing. Therefore, blending of devulcanized rubber wastes with thermoplastic, so called thermoplastic elastomer (TPE), is one of the best way to improve the ability to flow of devulcanized rubber wastes under heat and pressure. Futhermore, thermoplastic in the phase of rubber wastes can improve some mechanical properties of devulcanized rubber wastes. Thermoplastic elastomers are a new class of materials which combine the properties of vulcanized rubbers with the ease of processabilities of thermoplastics.

Shoe sole scrap is a by-product from rubber shoe factories. This scrap is generated after manufacturing or being cut into sizes. The amount of shoe sole scrap is about 20% by weight of shoe sole base before being cut and is increasing every month. This scrap is the composites consisted of natural rubber (NR), ethylene-vinylacetate (EVA), and low density polyethylene (LDPE) forming as a 3-layers structure. Because natural rubber is a thermoset polymer whereas ethylene-vinylacetate is partially crosslinked. Therefore, NR and EVA can not be melted, soluble, or remolded into other shapes without degradation. From this reason, shoe sole scrap is difficult to reprocess, leading to many problems regarding waste management and environmental problems.

Therefore, this research aimed to recycle and reprocess the shoe sole scrap into new product by preparing thermoplastic elastomer (TPE) between devulcanized shoe sole scrap and low density polyethylene (LDPE) at various ratios. The shoe sole scrap was devulcanized by thermo-chemical method using microwave energy and reclaiming agent, respectively. The effects of microwave power and devulcanizing time on gel fraction and swelling ratio of shoe sole scrap were investigated and the optimum condition to devulcanize shoe sole scrap was identified. Morphology of devulcanized shoe sole scrap was analyzed by scanning electron microscrope (SEM). In addition, the effects of devulcanization on mechanical properties (i.e., tensile strength, tear strength), physical properties (i.e., hardness, abrasion resistance), thermal properties (i.e., dynamic mechanical analysis), and morphology of the TPEs were investigated.