

## CHAPTER V

### CONCLUSIONS AND SUGGESTION

#### 5.1 Conclusions

##### 5.1.1 Preparation of Grafted Natural Rubber

The synthesis of the graft copolymerization of methyl methacrylate onto natural rubber was prepared by emulsion polymerization. The three different redox initiator systems, cumene hydroperoxide (CHPO)/tetraethylene pentamine (TEPA), tert-butyl hydroperoxide (TBHPO)/TEPA, and potassium persulfate ( $K_2S_2O_8$ )/sodium thiosulfate ( $Na_2S_2O_3$ ), were used to initiate the graft copolymerization. The influential factors of the initiator concentration, reaction temperature, monomer concentration, grafting agent (for  $K_2S_2O_8$ ), and reaction time were investigated to find the appropriate condition.

The appropriate condition for preparing the natural rubber grafted methyl methacrylate could be concluded as follows:

	CHPO/TEPA	TBHPO/CHPO	$K_2S_2O_8 / Na_2S_2O_3$
Rubber content (phr)	100	100	100
Vinyl neodecanoate: MMA	0:100	0:100	20:80
Monomer concentration (phr)	100	100	100
Initiator concentration (phr)	0.5	0.5	1.0
Reaction temperature ( $^{\circ}C$ )	50	50	60
Reaction time (hr)	8	8	8

The  $K_2S_2O_8 / Na_2S_2O_3$  was used with vinyl *neo*-decanoate (VneoD) as a grafting promoter to promote the grafting of methyl methacrylate in the natural rubber latex. VneoD has been observed to extract hydrogen from polyisoprene to form an allylic-type radical, which is relatively stable, suggesting that it could facilitate the grafting of methyl methacrylate onto natural rubber.

Grafting properties of grafted natural rubber are also presented as follows:

	CHPO/TEPA	TBHPO/CHPO	$K_2S_2O_8 / Na_2S_2O_3$
Conversion (%)	83.8	82.5	85.1
Grafting efficiency(%)	84.4	74.5	61.1
Graft properties			
-Graft natural rubber (%)	83.9	80.5	70.8
-Free NR (%)	8.8	7.5	11.4
-Free PMMA(%)	7.2	12.0	17.8

The graft copolymer initiated with CHPO/TEPA gave the highest percentage grafting efficiency and percentage grafted natural rubber. The more hydrophobic initiator, CHPO, was observed to be more efficient than those of TBHPO and  $K_2S_2O_8$ , respectively, for a grafting second monomer in the modified natural rubber.

The functional groups in the grafted natural rubber were characterized by FT-IR and NMR. The appearance of new peaks in the FT-IR spectra of grafted natural rubber was at around 1153 and 1736  $cm^{-1}$ , due to the ether linkage and carbonyl group of poly (methyl methacrylate) grafted on natural rubber backbone. The  $^1H$ -NMR spectra of grafted natural rubber exhibited the signal of  $-OCH_3$  proton of methyl methacrylate at about 3.6 ppm and the  $^{13}C$ -NMR spectra showed the signal of C=O and  $OCH_3$  of methyl methacrylate at about 178 and 57 ppm, respectively. For surface morphology by TEM

technique, the dark center particle is the natural rubber seed latex and the outer layer is composed of clusters of poly(methyl methacrylate) particles. The glass transition temperature of grafted natural rubber determined by DSC technique was at about  $-63$  to  $-65$  °C.

## 5.2 Suggestion

In the area of modification of natural rubber latex, further studies in the following aspects should be carried out.

- 1.) Elimination of non-rubber contaminants such as, proteins, from natural rubber before graft copolymerization should be performed.
- 2.) The mechanical properties of the polymer blends of NR-graft-MMA with polymers should be investigated such as, poly(vinyl chloride), poly(methyl methacrylate).
- 3.) Structure and adhesive property of the NR-graft-MMA should be studied in order to explore its application as adhesion.