



CHAPTER V

CONCLUSION AND RECOMMENDATION

In this research, an attempt was made to prepare graft copolymers of ST and ACN onto NR by both of solution and emulsion method. The effects of the initiator type, initiator concentrations, reaction temperature and N_2 pressure on the grafting properties were studied. The graft natural rubber (GNR) was also used as a compatibilizer for NR/NBR blends. The mechanical properties, oil resistance and morphology of the blends were also investigated.

5.1 The Preparation of GNR

5.1.1 Emulsion Method

The graft copolymerization of ST and ACN onto NR was carried out by emulsion polymerization initiated by redox initiator CHPO/TEPA and $K_2S_2O_8$. The appropriate conditions of graft copolymerization were found to be at 70°C under 2 bar of N_2 pressure with 2 phr of initiator concentration for 6 h. The CHPO/TEPA initiator gave slightly higher %monomer conversion (90.9%), %GE (96.4%) and %graft copolymer (78.6%) than $K_2S_2O_8$ system (89.6%, 95.2%, 77.8%, respectively). TEM micrographs of the GNR latex from emulsion initiator system showed the core shell configuration with complete closed shells of ST and ACN around the cores of each NR particle.

5.1.2 Solution Method

The graft copolymerization of ST and ACN onto NR was carried out by solution polymerization initiated by BPO and AIBN. The appropriate condition of both initiators was carried out under 2 bar of N_2 pressure at 70°C with 5 phr for BPO initiator and 80°C with 3 phr for AIBN initiator. It can be seen that BPO gave the higher %graft copolymer (85.1%) than AIBN (81.1%) because BPO could generate the comparatively higher radical reactivity than AIBN.

5.2 Structure and Composition of Graft Copolymer (NR-*g*-(ST-*co*-ACN))

The functional groups in graft copolymer were characterized by FTIR and NMR spectroscopy. The appearance of new peaks in the FTIR spectrum of (NR-*g*-(ST-*co*-ACN)) was at 2238 cm^{-1} attributed to the stretching vibration of $\text{C}\equiv\text{N}$ group, $\text{C}=\text{C}$ stretching vibration of the benzene ring of styrene at 1500 cm^{-1} and characteristic peaks of monosubstituted benzyl ring were also observed at 760 and 700 cm^{-1} . The copolymer composition of graft copolymer was confirmed by ^1H -NMR spectroscopy. The new signals at 1.25-3.20 ppm defined as the overlap signals consisting of methylene and methane protons obtained from ST and ACN and the peaks at 6.4-7.5 ppm which was noted as aromatic protons of ST in graft copolymer were appeared. To confirm FTIR and ^1H -NMR results, ^{13}C -NMR spectroscopic technique was also used to analyze the structure of NR and NR-*g*-(ST-*co*-ACN). The new signals in NR-*g*-(ST-*co*-ACN) structure appeared at 119.5 ppm and 30.6 ppm which were attributed to nitrile carbon (-CN) and carbon at polymer backbone bounded to nitrile carbon, respectively. The ratio of ST, ACN and isoprene monomer was calculated by using the number mole according to C, H and N in graft copolymer from CHN analyzer. It was found that contents of ST and ACN were maximum at 4.44 and 14.3 mole%, respectively when the graft copolymerization was initiated by 5 phr of BPO at 70°C under 2 bar of N_2 pressure for 6 h.

5.3 Utilization of GNR as Compatibilizers for NR/NBR Blends

GNR could be used as compatibilizers for NR/NBR blends. The cure characteristics of rubbers were evaluated by using an oscillating disk rheometer (ODR). The minimum and maximum torques of the blends with GNR also increased with increasing %graft copolymer in GNR when the content of GNR added into the blends was kept constant at 10 phr. Thus, GNR could be acted as an interfacial agent.

The mechanical properties of NR/NBR vulcanizates compatibilized by the addition of GNR were investigated. The results showed that the addition of GNR in NR/NBR blend at appropriate content could improve the mechanical properties of the blends such as tensile strength, % elongation, hardness and volume fraction. The tensile strength of the vulcanizates increased from 4.70 MPa to 12.1MPa when

%graft copolymer in the GNR (10phr) was in the range of 76-85%. The ultimate elongation of NR/NBR vulcanizates compatilized by GNR was also higher than that of ones without the addition of compatibilizers.

Swelling measurements was applied to NR/NBR vulcanizates with addition of GNR. The addition of 10 phr of GNR into the blend exhibited the higher oil resistance with increasing %graft copolymer in the GNR. This indicated that the addition of the GNR not only enhanced the mechanical properties of the NR/NBR vulcanizates by increasing the crosslink, it also acts as the oil resistance improver for these blends.

From SEM micrographs, the addition of suitable amount of compatibilizers into the immiscible polymer blend showed no phase separation appeared on the tensile fracture surfaces of NR/NBR vulcanizates. It could be concluded that the GNR having CN groups was the effective compatibilizer for NR/NBR blends to improve the interfacial adhesion and permit the finer dispersion resulting the better mechanical properties.

5.4 Recommendations

A further study of the graft copolymerization and polymer blend should be concerned with the following aspects:

1. By applying a different method and apparatus for graft copolymerization, the irradiation and microwave technique should be further studied to reduce time of the operation.

2. Appilcation of GNR as a compatibilizers for other polymer blends, having polarity difference e.g. fluorocarbon rubber (FKM) and NR.