CHAPTER 5

CONCLUSION AND SUGGESTION FOR FURTHER WORK

5.1 Conclusion

PCL/MMDI/TEA-based polyurethane (PU) and the semi-IPN of PU and PVC were prepared both by one-shot and prepolymer processes. It was found that the latter was the most appropriate method to prepare completely phase compatible semi-IPNs which was confirmed by SEM and physical observation of the product as optical transparent material.

The compatibility of those two phases was achieved due to the hydrogen bondings between α-hydrogen of PVC with carbonyl of PU prepolymer and with that of PCL. The glass transition temperature as obtained by DMA technique of the compatible semi-IPN was in the ranges of -4 - 8.6°C depending upon the equivalent ratio of NCO/OH used for the preparation of PU and the PVC content in the resulting polymer. The glass transition temperatures of PU prepared by the one-shot and the prepolymer methods were at -5.3°C and at -7.0°C, respectively.

Thermogravimetric Analysis (TGA) gives the information on the chemical compositions of PU and the semi-IPNs. For PU, it composes of two composition including the soft segment derived from the reaction of MMDI with PCL and the crosslinking from that with TEA. The weight losses of these two compositions were found at 300-430°C and at 430-480°C, respectively. For the semi-IPNs independent upon the preparation processes, the weight losses at 250-300°C, 300-430°C and 430-490°C were related to the three compositions including PVC, and the soft segment and the crosslinking of PU, respectively.

The mechanical properties including the tensile strength, the elongation at break and the Shore A hardness of PU and the semi-IPNs prepared by both of one-shot and prepolymer processes were measured. These properties were affected by the equivalent ratios of NCO/OH and of PCL: MMDI: TEA used for the preparation of PUs and the semi-IPNs. The former provides additional crosslinking derived from the secondary reaction of urethane linkages with NCO, i.e., allophanate linkages, in the case that the stoichiometric equivalent of NCO is greater than that of OH. The latter provide variation in the member of crosslinkings due to the reaction of TEA and MMDI in the resulting PUs.

The best properties of hardness and tensile strength of PU obtained in these studies when the equivalent ratios of NCO/OH = 1.05 and of PCL: MMDI: TEA = 1: 3: 2, which gave 7% crosslinking. The tensile strength, the elongation at break and the Shore A hardness of PUs obtained were respectively in the ranges of 1.16-5.17 N/mm^2, 203.5-451.3 %, and 46.4-68.0.

The tensile strength of 3.45-6.10 N/mm^2, the elongation at break of 199.2-557.3 %, and the Shore A hardness of 59.5-64.3 of the compatible semi-IPNs were obtained in these studies. For the PVC content was 10% weight by the total weight of the semi-IPN and the equivalent ratio of PCL: MMDI: TEA of the PU matrix at 1: 3: 2, the best mechanical properties of the semi-IPNs including the tensile strength of 3.79 N/mm^2, the elongation at break of 436.1%, and the Shore A hardness of 63.4 were found when the equivalent ratio of NCO/OH = 1.20.

For the fixed preparation formulation of PU, i.e., fix the equivalent ratios of NCO/OH at 1.05 and of PCL: MMDI: TEA at 1: 3: 2, and variation of the PVC content in the compatible semi-IPNs, the best mechanical properties including the tensile strength of 6.10 N/mm^2, the elongation at break of 545.4 % and the Shore A hardness of 61.6 were found when the PVC content was 30%. In addition it was also found that PVC acted as a plasticizes in the resulting semi-IPNs to have the softer and more flexible materials than the PVC-free PU. This evident was in contrast to the result of the studies carried out by Bandyopadhyay and Shaw (Bandyopadhyay, 1982) in that, for the PCL/MDI/TEA-based-PU blended with PVC, a larger amount of PVC was plasticized by a smaller amount of PU.

It is worth to note that the semi-IPN of PCL/MMDI/TEA-based PU (70%) with PVC (30%) has the mechanical properties in between those of the PVC-free PCL/MMDI/TEA-based PU and of PU-free PVC as shown in the table below

Materials	Tensile strength (N/mm^2)	Elongation at break (%)	Hardness
PU	3.45	323.3	69.1(Shore A)
Semi-IPN (PU 70/PVC30)	6.10	545.4	61.1(Shore A)
PVC	31-60	2-40	65-85(Shore D)

5.2 Suggestion for Further Work

These studies have been definitely incompleted because of the limitation of time as well as equipments, instruments and chemicals available. There are many topics which may require further studies prior to make corrective conclusions or to use the materials commercially. These are

1. The equivalent ratio of PCL: MMDI: TEA may be varied to be 1: 4: 3 and 1: 5: 4 in order to increase the crosslinking content in the resulting PU and semi-IPNs which should affect on their mechanical properties.

2. The amount of PVC in the resulting semi-IPNs may be increased more than 30% in order to obtain its optimum quantity that yields the optimum mechanical properties. Also, the synergistic effect of the PVC and the crosslinking contents in the resulting PU and semi-IPNs on their mechanical properties should be also investigated.

3. An organic diol-crosslinking agent such as 1,4-butanediol may be employed in place of TEA in order to prepare the hard segment in the

PU and to investigated the effect of its content on the mechanical properties of the resulting PU and semi-IPN.