CHAPTER VIII
CONCLUSIONS AND RECOMENDATIONS

8.1 Conclusions

The electromechanical properties of the AR71:undoped PPP blends, with PPP particle volume fractions of 5, 10, 20, 25, 30 and 40 %vol, the dynamic moduli, G′ and G″ of each blend, are higher than those of pure AR71. Their storage modulus sensitivity ($\frac{\Delta G'}{G'_0}$) increases with electric field strength; it attains a maximum value about 97% at E = 2 kV/mm. The effect of temperature is to increase the storage modulus of pure AR71 and poly(p-phenylene)/AR71 linearly. For pure AR71 and AR71:30un systems, in conformity with the classical rubber elasticity, the effect of temperature and electrical strands induce an increase in G′ linearly with temperature. With PPP particles present, the effect of electrical strands induced becomes more dominant.

The electromechanical properties of AR70, AR71, AR72, SAR, SIS D1112P, and SBR were investigated by examining the effects of temperature, conductivity, and dielectric constant on the dynamic modulus, G′, under the oscillatory shear mode at an electric field strength varying from 0 to 2 kV/mm. The dielectric constants and specific electrical conductivities of the elastomers increase with increasing temperature. In the case of the acrylic elastomers, the storage modulus responses and sensitivities increase linearly with temperature. For the styrene copolymers, the storage modulus responses and sensitivities attain their maximum at the T_g of the hard segment. The storage modulus responses of AR70, AR71, and AR72 are correlated positively with dielectric constant. On the other hand, the storage modulus responses of SAR, SIS D1112P, and SBR may increase and decrease with increasing dielectric constant, depending on whether the operating temperature is below or above the T_g of the hard segment.

The deflection angle and the dielectrophoresis force of AR70, AR71, AR72, SAR, SIS D1112P, and SBR were investigated by examining the effects of the DC electric field strength and the dielectric constant. The deflection angle and the

dielectrophoresis force of all elastomers increases with electric field, and becomes saturated at high electric field strength for AR71 and AR72. Both parameters increase nonlinearly with increasing dielectric constant. The materials with high dielectricity require low electrical energy to respond. The acrylic elastomers (AR70, AR71, and AR72), styrene-butadiene rubber (SBR), and styrene-isoprene-styrene triblock copolymer (SIS) deflect towards the anode side under applied electric field due to the polarity of polar groups on the polymer chains (Behl *et al.*, 2007). On the other hand, the styrene-acrylic copolymer deflects towards the opposite side. This behavior results from the Cu and Zn metal ions residing within the SAR. The ions can be ionized to become positively charged (Cu^{2+} and Zn^{2+}) under applied electric field

Finally, the deflection angle and the dielectrophoresis force of AR71, SAR, and SBR were investigated by examining the effects of the amplitude of AC field strength, the frequency, the thickness of specimens and the particles concentration. The deflection angle, the force and the cut-off frequency of the elastomers increase with increasing amplitude of AC field. But the deflection angle and the force decrease with increase of frequency. The optimum thickness of AR71 is 0.25 mm which give the highest deflection and dielectrophoresis force at E = 800 V/mm. The deflection angle and force increases beyond the concentration of 10 %vol PPP at E = 800 V/mm. However, both decrease at 20 %vol because the stiffness and rigidity of polymer blends.. The cut-off frequencies of all polymer blends are higher than that pure AR71. The conductive particles act as a filler and can be used to improve the electromechanical responses of materials at high frequency.

8.2 Recommendations for Future Work

The new actuator devices that require the low power consumption are prepared. The electromechical properties of AR71:undoped PPP blends in oscillatory shear have been investigated. Some important effects should be studied for examples the doping ratio, the morphology of blends, and more understanding in the electromechanical fundamentals.

In the deflection experiment, various types of electrode, the operating temperatures, the morphology of polymer blends, and the types of fillers would provide useful data that are applicable to develop a new type of a low power consumption actuator.