CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

The influence of dispersed-phase elasticity on droplet behavior and steady-state morphology of immiscible blends in simple shearing flow is investigated. The blends of "Boger" fluids, i.e. polybutadiene "Boger" fluid/poly(dimethyl siloxane) blends, and high-molecular-weight polymer melt blends, i.e. polystyrene/high density polyethylene blends, are used for this study. To isolate the contribution of droplet elasticity, all experiments were carried out at a fixed viscosity ratio of around unity. For blends of "Boger" fluids, as the droplet-phase elasticity increases, the steady-state shape deformation of isolated droplets at fixed capillary number, Ca, decreases and the critical capillary number for droplet breakup (Ca_{crit}) increases. The critical capillary number for breakup (Ca_{crit}) increases linearly with the Weissenberg number of the droplet phase (Wi_d) up to a value of Wi_d of around unity. When Wi_d is greater than unity, Ca_{crit} seems to approach an asymptotic value of 0.95 for high values of Wi_d. Droplet widening in the vorticity direction is not observed even at droplet Weissenberg number up to around 3. The steady-state capillary number (Ca_{ss}) obtained from the average steady-state droplet size in blends of "Boger" fluids containing 10% or 20% by weight of dispersed phase is less than the value of Ca_{crit} obtained for an isolated droplet of the same fluid in the same matrix fluid used in the blend because the flow in the blend is locally highly nonuniform and non-steady due to the presence of many other droplets in the vicinity of any one droplet. Ca_{ss} is found to increases monotonically with the first normal stress difference of dispersed phase (N_{1d}). For high-molecular-weight polymer melt blends, the viscoelastic droplets initially deform in the flow direction after startup of steady shear, but then begin reverting to a spherical shape, and, for the more elastic blend, eventually deform in the vorticity direction. With increasing capillary number, the droplet deforms increasingly along the vorticity direction. The alignment in the vorticity direction for highly elastic droplets lead to large increases Ca_{crit}, compared with the Newtonian blends. For 20%-dispersed phase blends of high-molecular-weight polymer, the values of steady-state capillary number (Ca_{ss}) were found to increase

with the ratio of first normal stress difference of dispersed to that of matrix phase and followed a power law with scaling exponents between 1.7 and 1.9.

Although this research work provide a clearer correlation of average droplet size with droplet elasticity under better controlled conditions than has heretofore been achieved, more experiments, and especially numerical simulations of droplet breakup and coalescence for fluids modeled by well defined constitutive equations, will be needed to provide further clarification and more precise correlations.