# CHAPETER IV
# RESULS AND DISCUSSION

## 4.1 Particle Size of NR Latex

The volume distribution of the NR latex after purification is shown in Figure 1. The particle size analyzer shows that NR latex particles have volume diameter 0.63 ± 0.42 μm and specific surface area 9.7 $m^2$ /g. This result compares well to values (Tangboriboonrat *et al.* (1995)) indicating that NR latex is naturally polydispersed wide size distribution.

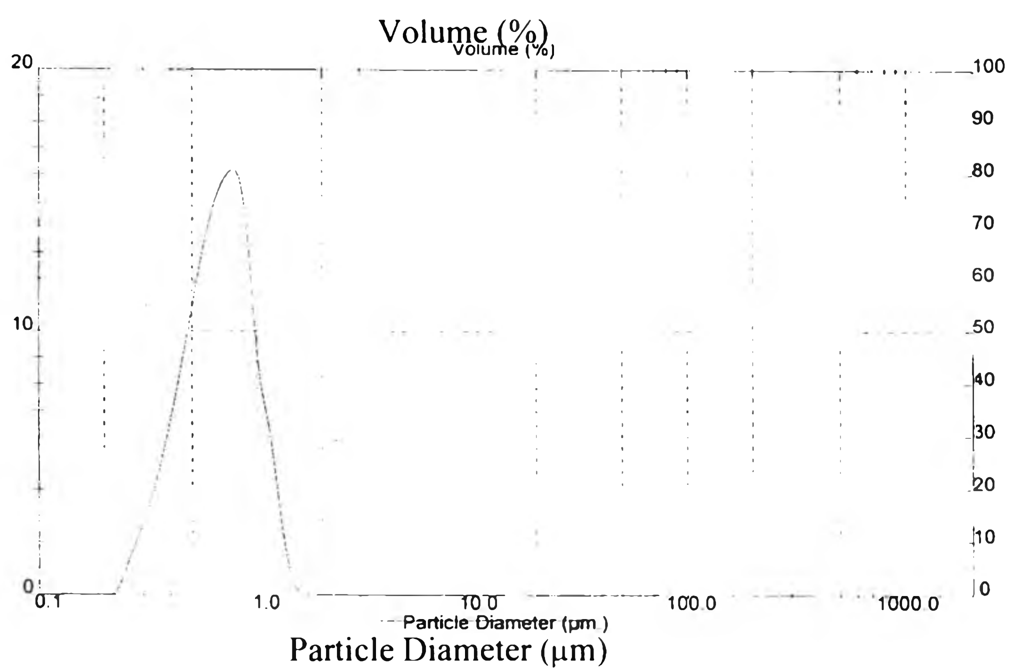



**Figure 4.1** Histogram of particle size distribution of NR latex particle.

## 4.2 Electrophoretic Mobility

The electrophoretic mobility of the colloidal dispersion of NR latex with various pH in the solution is illustrated in Figure 4.2. The net surface charge of zero (or the point of zero charge, PZC) can be known by the intersection of the electrophoretic mobility curve and the zero axis. As shown in this Figure, the net zero charge on surface of NR latex particle is found at pH 3.9 at room temperature.

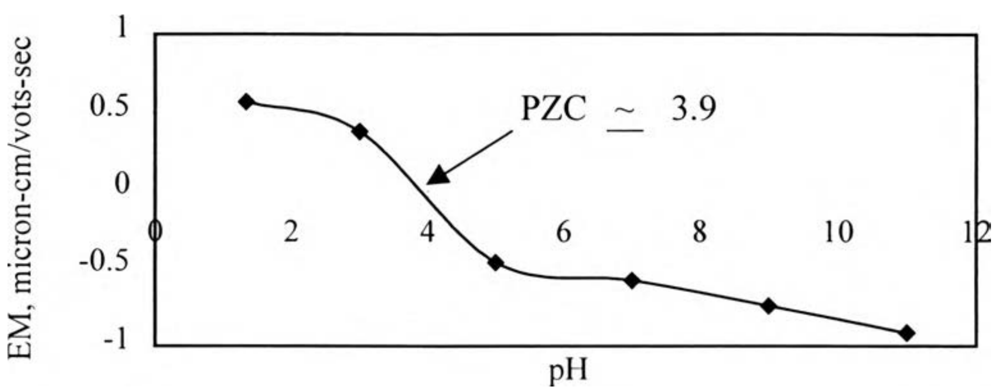



**Figure 4.2** The elecrtrophoretic mobility of charged latex particle in aqueous solution at various pH.

At pH values below PZC, the latex particle exhibits a positive charge. Above the PZC value, the surface changes to a negative charge. The NR structures consist of phospholipids at the outer layer associated with protein which is anchored to the rubber surface. The phospholipid structure exhibits a positive charge, while the protein structure offers a negative charge. The result from electrophoretic mobility helps with the wide selection of surfactant types to adsorb on latex surface. Anionic surfactants can be adsorbed below the PZC while cationic surfactants are adsorbed above the PZC. In this study, the anionic surfactant, SDS, was employed so that pH in the solution was adjusted to pH 3 where it was adequate to promote SDS adsorption onto latex particles . SDS was particularly attractive as surfactant because there was a precedent for the polymerization of pyrrole in its presence.

### 4.3 SDS Static Adsorption Isotherms

The static SDS adsorption was studied with various pyrrole concentrations as shown in Figure 4.3. Pyrrole causes a decrease in surfactant adsorption in accord with prior work (Funkhouser *et al.* (1995)). Both pyrrole concentrations at 10 and 20 m give similar results of SDS adsorption isotherm.

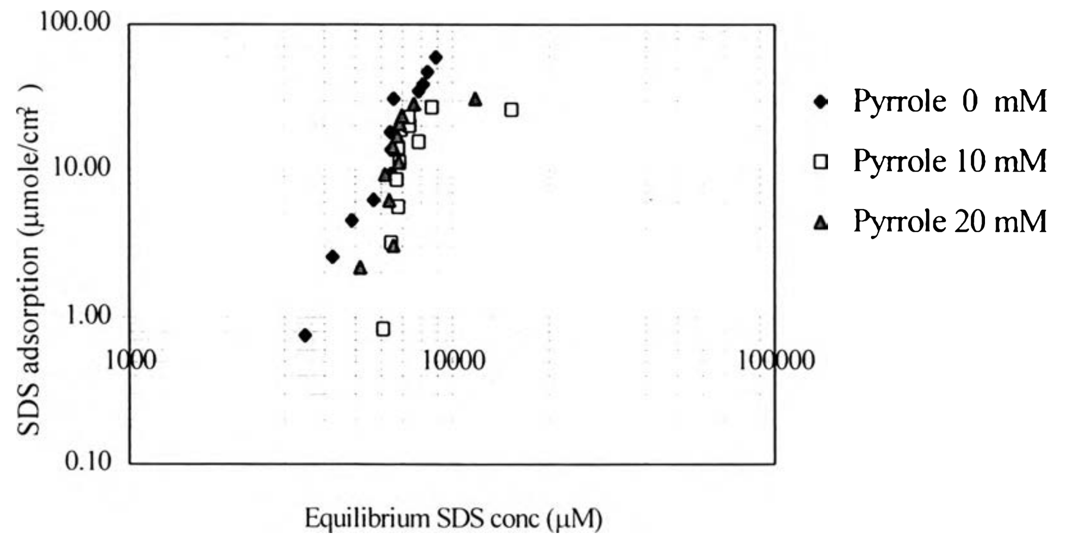



**Figure 4.3** Adsorption isotherm of SDS on latex particle at various pyrrole concentrations.

Figure 4.4 illustrates that the salt overwhelms the effect of pyrrole on the adsorption isotherm of SDS. Salt improves the SDS adsorption, which is in accord with the previous work (Funkhouser *et al.* (1995)).

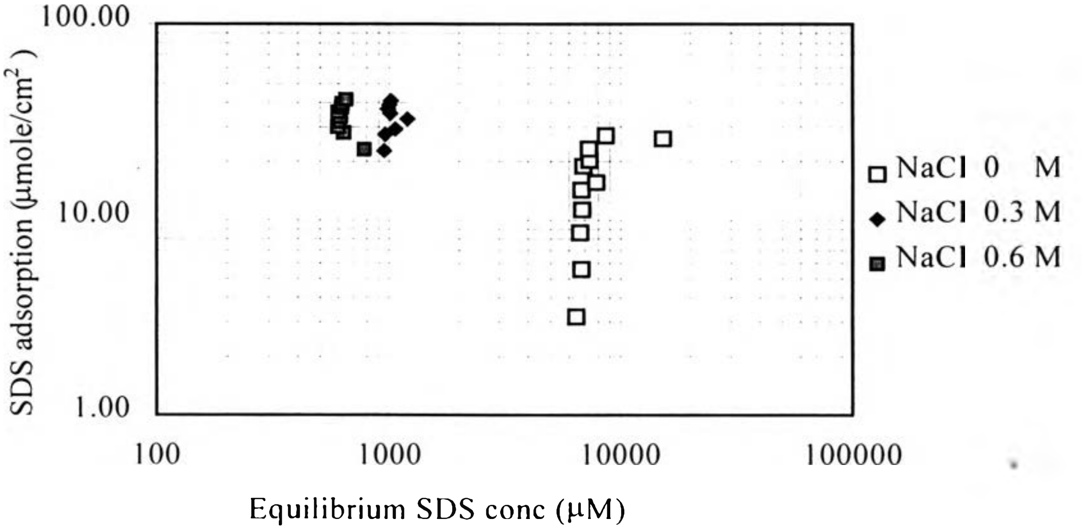



**Figure 4.4** Adsorption isotherm of SDS on latex particle at various salt concentrations. The initial pyrrole concentraiton was 10 mM in all cases.

### 4.4 Pyrrole Adsolubilization

Figure 4.5 shows that the adsolubilization of pyrrole increases with the addition of salt. This result agrees with the previous work on the adsolubilization of pyrrole in SDS admicelles on alumina. Funkhauser explained that pyrrole was a highly hydrophilic species which adsolubilized in the head group region in the bilayer. However, it lacked significant hydrophobic groups, so decreasing adsorption was found. The salt decreases electrostatic repulsion between head groups to allow more adsorption and adsolubilization.

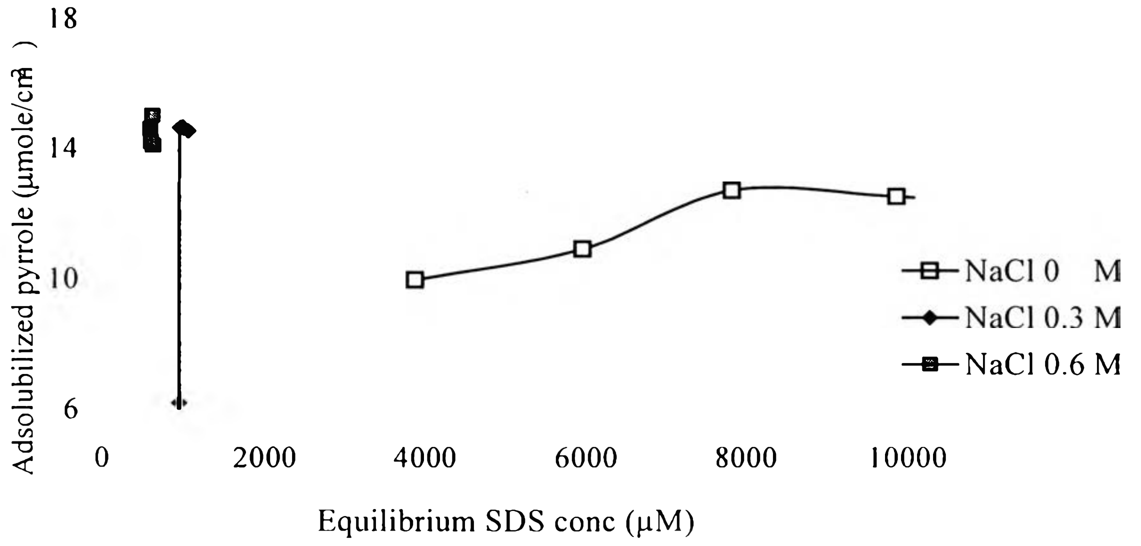
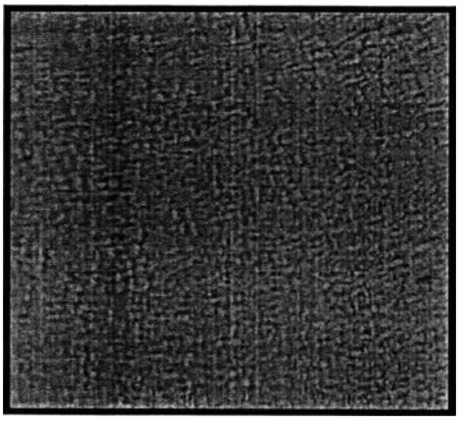


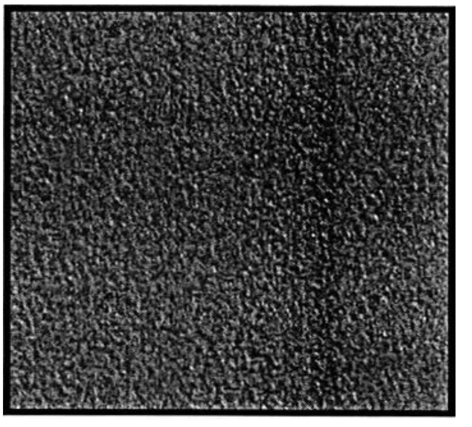

**Figure 4.5** Pyrrole adsolubilizaition in SDS admicelle onto latex particle at various salt concentrations. The initial pyrrole concentration was 10 mM in all cases.

### 4.5 Polymerization of Pyrrole

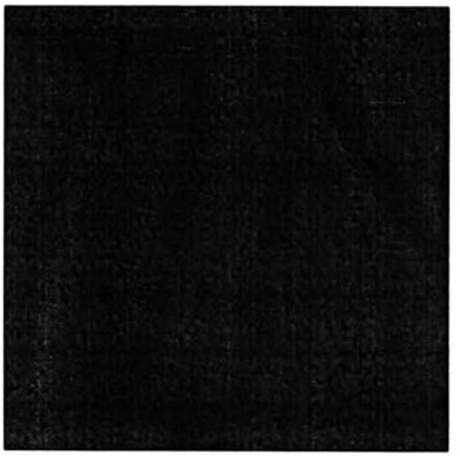
The polymerization condition of the PPy film on the NR latex particles was prepared from three solutions of (i) pyrrole (ii) pyrrole and SDS and (iii) pyrrole, SDS and salt. The morphological structures of the dried NR latex before and after coated with PPy are shown in Figure 4.6. The conductivity of the film is presented in Table 2.



Bare latex



(i) pyrrole 10 mM



(ii) pyrrole 10 mM and SDS 16 mM

(iii) pyrrole 10 mM, SDS 16 mM and NaCl 0.6 M

**Figure 4.6** Optical microscope of NR latex particles.

**Table 4.1** Polymerization conditions and the characteristics of the polypyrrole with NR latex particles. The initial pyrrole concentration was 10 mM in all

| No | SDS concn (mM) | NaCl concn (M) | NaCl concn (M) | Color* |
|---|---|---|---|---|
| i | 0 | 0 | $2.062 \times 10^{-6}$ | ++ |
| ii | 16 | 0 | $0.959 \times 10^{-6}$ | + |
| iii | 16 | 0.6 | $1.449 \times 10^{-6}$ | + |

*+ is light, - is dark

In sample (i) without SDS, PPy appeared to distribute in an aqueous solution of NR latex and was not adsorbed onto the latex particles. In other words, this sample has no surfactant to act as emulsifier for PPy coating onto latex particles. The electrical transport of PPy is relatively good because PPy is connected and distributed continually throughout the dried film to allow electrical conductivity. In the film sample (ii) produced from drying solution of pyrrole and SDS without salt, the conductivity is reduced by half. Thus, the presence of SDS seems to obstruct electrical transport. Sample (iii) is obtained from the solution of pyrrole, SDS and salt. It shows increased conductivity about 50% compared to that of sample (ii). As stated earlier, when there is no salt, the repulsion of SDS head groups is maximized and the pyrrole adsolubilization is minimized due to the poor hydrophobicity. This may cause to form irregular and reduced adsolubilization of pyrrole around latex particles. Thus, the connectivity of PPy is relatively poor. The addition of salt improves the adsolubilization of pyrrole in the SDS admicelle by reducing the repulsion, so more pyrrole is adsolubilized and coated more homogeneously onto the surface of latex particles and the conductivity can be enhanced. It can be thought that defects may be formed where some parts of NR latex particles were not coated by PPy. However, it is noted that the low initial pyrrole concentration and the non-uniform sphere[13] with wide distribution of NR particle size contribute to the low conductivity of all samples.