CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Bacterial cellulose (BC) were blended with poly(vinylidene fluoride) (PVDF) by using DMF as a dispersing medium which help to obtain a homogeneously dispersion of nano-fiber in PVDF matrix. The PVDF/BC blend films were prepared using solvent-cast followed by hot-pressing methods. The SEM micrographs indicated that the BC in casted blend films explored the diameter in nano-scale (about 40-50 nm.) which yield to high surface area and create more intermolecular interaction between oxygen atoms and fluorine atoms. These bio-based nanocomposite films showed the combination of β and α polymorph which had a major form in β piezoelectric phase. The T_g and dynamic T_g of PVDF/BC blends were slightly decreased as increasing BC content. In contrast, the network fiber interrupted the movement of PVDF chain in molten state resulting in enhanced the T_m of nanocomposite films about 1-2 °C higher than that neat PVDF. The thermal stability of PVDF region in the blend were significantly improved as observed T_d of the blends higher than T_d of neat PVDF about 15-45 °C depend on compositions. The $PVDF_{90}BC_{10}$ film showed dielectric and ferroelectric properties higher than other components.

$PVDF_{90}BC_{10}$ was chosen to study the effect of MWCNT loading. For tertiary blend of PVDF/BC/MWCNT, the dielectric enhancement was obtained at near percolating threshold which a conductive phase (MWCNT) influenced to increase dielectric constant about 9 times of magnitude at frequency of 10 MHz- 1 GHz. The molecular motion in PVDF of the blends exhibited single relaxation which fitted to Arrhenius law. The addition of MWCNT 3 phr into $PVDF_{90}BC_{10}$ matrix exhibited highest remanent polarization and the d_{33} coefficient reached -15 pC/N.

6.2 Recommendations

1. For piezoelectric constant investigation, d_{33} meter was carried out to measure the in-plane piezoelectric coefficient. But d_{33} meter is more suitable with piezoelectric ceramic than polymer and cannot measure as a function of frequency, temperature and stress. For observing piezoelectric behavior of polymer, the thermal stimulated current measurement (TSC) is more suitable. TSC is used to measure polarization and induced charge to investigate piezoelectric coefficient as a function of electric field, frequency and stress. However, TSC machine does not exist in Thailand.

2. In order to develop this bio-piezoelectric composite as a transparent touch sensor to use in monitor, the % light transmittance should be concerned. Due to the appearance of MWCNT is black color result in the blend showed low % light transmittance. The other type of filler should be studied.

3. The mechanical properties (tensile and flexural) should be measured to confirm the superior properties of nanocomposite film. But the neat PVDF and it blends were slip during the measurement.