



## CHAPTER VI

# CONCLUSIONS & RECOMMENDATIONS

### 6.1 Conclusions

In this research, the synthesis polyimide and compare hyperbranch polyether on polyimide properties were investigated.

#### 6.1.1 Synthesis of polyimide and first layers

The polyimides were synthesized using the one-step method and by incorporating POSS-Cl to outer space of polyimide were studied. A number of conclusions may be summarized as follows:

1. From FT-IR spectrum, it indicated the incorporation of POSS-Cl in polyimide structure.
2. From TGA, the thermal properties of POSS-PI (first layer) polyimide indicated that  $T_d$  were lower than  $T_d$  of the pure polyimide.
3. From dielectric constant, by incorporation POSS can decrease dielectric constant of polyimide and confirm by density of measure density.

#### 6.1.2 Synthesis of hyperbranch polyimide.

The conclusion of this research can be summarized as follows,

1. From TGA, thermal properties was lower pure polyimide and first layer and appeared first stage at about  $250^{\circ}\text{C}$  because the degradation of branch ether, So the thermal properties of hyperbranch polyimide indicated that  $T_d$  were lower than  $T_d$  of the pure polyimide.
2. From DMA, the decrease in mechanical properties due to the cooperation of POSS in the Polyimide molecules. The free volumes of the branches are higher than the pure polyimide and the  $T_g$ , loss modulus, storage modulus of the hyperbranch ether is lower than the polyimide, so the  $T_g$  of the composite has the tendency to drop

down. The higher is the free volume, the lower is the density and mechanical properties.

3. From dielectric constant, the higher is the POSS cooperation, the lower is the dielectric, if the comparison are in the same level of branches. However, the higher are the branches, the lower is the dielectric, even if the branches have less than four times of the cooperation of POSS.

4. From solubility, hyperbranch polyimides have better solubility than the pure polyimide due to the branched structure.

## 6.2 Recommendations

6.2.1 There should be more investigation in the properties of the PI50 because the dielectric and the density were minimal and the proper conclusion cannot be drawn in this thesis.

6.2.2 The Coefficients of Thermal Expansion (CTE) should be explored and compare with the other properties.

6.2.3 The more conclusions on the tensile strength of various composite should be composed.