CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

The polymer matrix of the composite was chosen between aniline based and fluorine based benzoxazine monomer which was synthesized from paraformaldehyde, aniline and bisphenol A by solventless method (in case of fluorine based benzoxazine monomer the hexafluorobisphenol A was used instead of bisphenol A).And the curing temperature of aniline based and fluorine based benzoxazine monomer were 218°C and 227°C as seen in DSC thermograms. Microwave dielectric properties of aniline based benzoxazine monomer showed higher dielectric constant than fluorine based benzoxazine monomer, 6.12 and 4.49, respectively at 1 GHz. While, loss tangent of both benzoxazine based showed the value lower than 0.03 which id the acceptable range for high frequency application. Thus, aniline based benzoxazine monomer was used as a polymer matrix in composites. For ceramic phase, in this work the $Ba_{0.3}Sr_{0.7}TiO_3$ (BST) was proposed. BST was synthesized from sol-gel method then calcined at 1000 °C to obtain the single phase of perovskite. XRD patterns showed the absence of peak at (200)/ (002) at 2θ = 46.1°, that means the crystal structure of calcined BST was cubic structure and BST particle mostly agglomerate and uniformly particle size and shape distribution as shown in TEM image. The thermal stability and stiffness of the composites were improve by the increasing of ceramic content in composite which were observed from the higher of glass transition temperature (T_g) and higher decomposition temperature (T_{d10}) of the composites (T_g and T_{d10} of the pure polymer are 183°C and 215°C, respectively while the composite with 80 wt% BST is 211°C and 392°C, respectively). Furthermore, the microwave dielectric properties were studied. The increasing amount of BST filler in composites result to higher in dielectric constant and loss tangent. By adding 80 wt% (48 vol%) of BST, It was showed the dielectric constant as high as 22 at 1 GHz (about three times of pure polymer). Dielectric constant of the composite was weakly dependence on frequency while showed independence on temperature effect. The higher loss tangent was showed at high frequency (1 GHz) which was the effect of the agglomeration of BST filler. In order to improve dielectric properties of the composites the surface modification method was proposed to modify the BST powder by using 3 different chemical reagent such as silane coupling agent (3-aminopropyl trimethoxy silane), phthalocyanine and benzoxazine monomer. From the SEM micrographs showed that at the same ceramic content, the less agglomeration was observed in composite with treated BST filler. Moreover, silane coupling agent could improve the dielectric constant to highest value compared with other surface treatment agents due to the covalent bonds which occur between interface of polymer and ceramic phase that lead to total polarizability of the composites increase. While, phthalocyanine and benzoxazine monomer consist of aromatic rings (bulky group) in their structure so, it could prevent the BST come closer and contribute to BST de-agglomerate in polymer matrix resulting in lower dielectric loss. The effect of frequency and temperature was also studied. It was found that the dielectric constant and loss tangent of the modified composite independence with frequency and temperature. Implied that at microwave frequency and high temperature, the surface treatment agent can work well.

Recommendations

1. The composites should be fabricated as thin film by using spin coating technique which may help to reduce air bubbles in the specimen.
2. The metal should be dope to BST ceramic in order to improve the dielectric properties.
3. The new based of polybenzoxazine which has conducting group should be synthesize.