

CHAPTER 5

CONCLUSION AND FUTURE RECOMMENDATIONS

5.1 Conclusion

In this research, the formulation for the viscosity of PHB/UDMA resin blend act as a pivot to define a success printability of 3D structures in particular for stereolithography (SLA) technique. The incorporation of polyhydroxybutyrate (PHB) within urethane dimethacrylate (UDMA) based resin is able to retain the mechanical integrity in terms of its strength over a month. 7 wt.% of PHB content shows a declination of tensile strength at only 5% compared to the 3D printed pure UDMA which is approximately about 13%. Meanwhile, the impact strength displays a minimal reduction of about 3% for the same composition aforementioned instead of 16% portrayed by the 3D printed pure UDMA. Fourier-transform infrared spectroscopy (FTIR) indicates that all of the composition of PHB/UDMA resin blend has surpassed the standard level degree of double bonds conversion (DC) required for the clinical application except for only 3 wt. % of PHB content. The crystallinity index obtained from x-ray diffraction (XRD) is increased along the addition of PHB loading, attributed from the presence of crystalline structure within UDMA based resin, thus the brittleness of 3D printed PHB/UDMA is also increased. Field-emission scanning electron microscopy (FESEM) displays the occurrence of PHB's agglomeration that indicates the poor interfacial adhesion between two immiscible polymer blend of PHB particles and UDMA matrix. 3D printed pure UDMA exhibits better thermal stability compared to others is portrayed by thermogravimetric analysis (TGA). A 3D printed arm cast had been successfully fabricated using 7 wt. % of PHB content, which comes with several features such as custom-fitted, ventilated structures and lightweight. The selection of

this composition is due to a better mechanical performance and surpassed the standard minimum level of DC. This research has shown in-depth relationship between the printability and mechanical properties of PHB/UDMA resin blend as a 3D printing material. In a nutshell, additive manufacturing specifically SLA has a great potential to develop a medical device specifically 3D printed arm cast due to its highly customizability in fabrication of complex and ergonomic structure.

Table 5.1: The Summary Characterizations of 3D Printed PHB/UDMA.

Characterizations	Descriptions
Viscosity	The formulation act as a pivot to define success printability.
Mechanical	The incorporation of PHB could retain the mechanical strength.
FTIR	Only 7 wt. % and 11 wt. % PHB/UDMA passed the minimum DC required for clinical application.
XRD	The crystallinity index increased correlated with the reduction of mechanical performance.
FESEM	Two distinct phases region between PHB and UDMA indicate poor interfacial adhesion.
TGA	3D printed pure UDMA exhibited better thermal stability.
3D printed arm cast	Has been successfully fabricated.

5.2 Future Recommendations

This research only focused on the printability and mechanical performance of PHB/UDMA and the feasibility to develop a 3D printed arm cast. For further expansion of studies, there are some recommendations regarding to this work:

- 1) The addition of third component as a compatibilizer between PHB and UDMA to enhance the interfacial adhesion for better mechanical performance.
- 2) For further clinical trials, a pilot study consists of several set of actual patients are required to evaluate the feasibility of the 3D printed arm cast.

- 3) The evaluation of biocompatibility test under biological response towards skin contact.

