CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The following conclusions are drawn on the basis of experimental results, data analysis and discussion in the preceding chapter:

1. A domestic microwave oven can be modified to develop a suitable technique for sintering metallic product.
2. Insulation of the metallic products and temperature control are crucial in microwave sintering.
3. The specimens sintered with high temperature (>220°C) swell regardless of the type of sintering, compaction pressure and sintering time, while sintering at low temperature (<220°C) results in shrinkage.
4. Microwave sintering of tin-copper-antimony alloy compacted at a pressure of 312MPa and sintered at a temperature of 140°C for a time duration of 60 minutes gives best dimensional accuracy to the product.
5. When precise dimensional accuracy is not required in the product, the green compact should be sintered by microwave heating and higher compaction pressure, lower sintering temperature and longer sintering time should be used.
6. Microwave sintering gives higher density and slightly higher open pore porosity as compared to the conventional sintering under similar operating conditions.

7. Hard intermetallic phases segregate better with conventional sintering as compared to microwave sintering, giving higher hardness to the sintered products; particularly when sintered at higher temperature and longer time.
8. Microwave sintering yields higher densities especially when the temperature is low. However, when the temperature is high, conventional sintering is a better option for lower compaction pressured specimens. Microwave sintered specimen has higher density when the compaction pressure is high.
9. Type of sintering and compaction pressure has significant effect on density. The type of sintering constitutes 19.8% to density and compaction pressure having 14.9% constituent. Sintering temperature has a complex interaction effect with compaction pressure, type of sintering and sintering time.
10. Similar optimum conditions were obtained from iso-level S/N ratio value technique as with Pareto ANOVA.
11. For getting high density, optimum combination of input parameters is $A_1B_1C_0D_0$ (220°C sintering temperature, 312MPa compaction pressure, microwave sintering and 30 minutes sintering time).
12. Largest contribution to the open pore porosity is from compaction pressure (96%) while other factors contribute less. However, the optimum combination of input parameters for highest porosity is $A_1B_0C_0D_0$ (220°C sintering temperature, 156MPa compaction pressure, microwave sintered and 30 minutes sintering time).
13. Sintering temperature constitutes 54.8% to the hardness. The constituent of type of sintering is 19% and the time of sintering is 16.7%. For getting high hardness, the optimum combination of input parameters is $A_1B_0C_1D_1$ (220°C

sintering temperature, 156MPa compaction pressure, conventionally sintered and 60 minutes sintering time).

14. There is no oxidation for the microwave sintered specimen.
15. Microwave sintering gives better surface finish than conventional sintering.

6.2 Recommendations

The following suggestions are recommended for future work:

1. Metallic products other than tin base alloy can be used for microwave sintering.
2. The fluctuation of temperature controller should be eliminated or minimized to a smaller range.
3. Other material properties such as wear resistance, radial crushing strength and tensile strength should be investigated after microwave sintering and find the optimum combination of input parameters.
4. Increase the number of replications to minimize the noise factor effects.
5. Better insulation should be promoted to the present experimental setup to accommodate other sizes of specimen.
6. The conclusion drawn regarding the formation of larger amount of hard intermetallic compounds under conventional sintering at high temperature for longer time is based on circumstantial evidence. Further work is needed to confirm this conclusion. EDX or chemical analysis of the specimens may provide better evidence.