CHAPTER 6

CONCLUSION

6.1 CONCLUSIONS

This research work identified four important process parameters such as slice thickness, road width, liquefier temperature and air gap that had significant effect on the surface quality and structural integrity in terms of porosity, surface roughness and dimensional accuracy of the parts produced by FDM.

It could be observed that surface roughness increased with increase in road width and air gap and decreased with increase in slice thickness. The optimal liquefier temperature for better surface finish was found to be 275°C. The minimum road width of 0.305 mm, high negative air gap of -0.01 mm and slice thickness of 0.254 mm were found to be optimum for better surface finish of the RP components produced by FDM.

The road width is found to be the most effective parameter affecting the surface quality and porosity of the part produced. Increase in road width and temperature reduce the porosity. Similarly negative air gap also lowered the porosity and improved structural integrity. The liquefier temperature of 290°C, air gap of -0.01 mm, road width of 0.8 mm and slice thickness of 0.178 mm were found to be the optimal values for minimum porosity.
It is observed that liquefier temperature is the most significant parameter influencing width-reduction (shrinkage) of the RP parts. Apart from the liquefier temperature, air gap and slice thickness also influence width-reduction. For least reduction in width, the process parameters, such as liquefier temperature, air gap and slice thickness were evaluated to be optimal at 290°C, -0.005 mm and 0.178 mm respectively.

Road width is the most significant parameter that influencing the deviation in thickness. It could be observed that the increase in slice thickness from 0.178 mm to 0.254 mm has not significantly produced any change in thickness of the RP components produced. But the road width can play a significant role in the same. For a road width of 0.4 mm, slice thickness of 0.254 mm, air gap of 0.00 mm and liquefier temperature of 290°C, the deviation in thickness of the RP product has been found to be minimum.

The regression statistics proved that the mathematical models developed have a high precision. Hence, those models could be used to predict the surface quality in terms of porosity, surface roughness, percentage of thickness deviation and percentage of reduction in width within the range of various significant process parameters with 95% confidence level. The developed artificial neural network models could be used to predict the process (input) parameters as well as the output responses accurately, which the simulation could effectively use them to predict the optimal process parameters.

Based on the SEM analysis the following observations have been made

- When the road width was increased, larger deposition took place and hence the cooling rate was not uniform, which resulting in
poor surface finish. Macrographs also showed non-uniformities in the road shape and surface.

- The macrographs showed the sub-perimeter voids and inter-road gaps which led to more porosity of the rapid prototypes.
- At higher temperatures and higher negative air gap, the air entrapment was less, resulting in better surface quality.
- At higher slice thickness, minimum deviation in component thickness was observed and hence, better dimensionally accurate products can be produced.

6.2 SCOPE FOR FUTURE WORK

1. Further work in FDM process by varying other process variables such as flow rate, envelope temperature, speed of deposition etc., would be of great interest to carry out process optimization and develop process modeling based on the statistics of the experimental results.

2. The number of process parameters can be increased and level of each process parameter can be varied and hence, database can be improved by extensive experimentation.

3. The experimental work can be extended for other materials and the effect of material property on surface integrity.

4. The work can be compared with other related RP techniques.
5. The same work can be analyzed using other techniques such as goal programming, fuzzy logic etc. and their effectiveness can be compared.

6. Further study with different geometrical features can also be done.