

DEVELOPMENT OF PREDICTIVE MODELS FOR THE COALESCENCE OF
FUSED DEPOSITION MODELING FIBERS

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by

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS	ii
ABSTRACT	viii
1. Introduction	1
1.1 Additive Manufacturing	1
1.2 Fused Deposition Modeling	2
1.3 Weak Mechanical Properties of FDM part	3
1.4 Methods for Improving FDM Mechanical Properties	5
2. Literature Review	6
2.1 Sintering Model Applied to FDM wetting	6
2.2 Heat Transfer Analysis across Fibers	7
3. Methodology	9
3.1 Bonding Model	9
3.1.1 Bonding Equation	9
3.1.2 Temperature-Dependent Viscosity	13
3.2 Thermal model	14
3.2.1 Fiber Geometry	15
3.2.2 Temperature profile of the fiber	15
3.2.3 Temperature Dependent Thermal Conductivity and Heat Capacity	19
3.2.4 Convective Heat Transfer Coefficient	20

4. Model Validation.....	23
4.1 Materials and Equipment for Printing the Sample	23
4.2 Sample preparation.....	23
4.2.1 Sample for Image Analysis.....	23
4.2.2 Sample for Tensile Testing.....	25
4.2.3 Sample for Post-processing	26
4.3 Tensile Testing	27
4.4 Image Analysis	31
5. Case Studies.....	35
5.1 Cooling and Bonding Result	35
5.2 Observation of Bond Length Using SEM.	38
5.3 Miniature-tensile test.....	40
5.4 Miniature-tensile Test for Post-process Samples	40
6. Discussion.....	41
6.1 Cooling and Bonding Models	41
6.2 Bond Strength Between FDM Fiber.....	43
6.3 Post-process of FDM Part	45
7. Conclusions	46
References Cited.....	49
Appendices.....	53

Appendix A - Polycarbonate Properties Data Tables.....	53
Appendix B - Matlab M-files	55

LIST OF ILLUSTRATIONS

Figure	Page
Figure 1. 1 Inter- and intra- layer bonding in FDM.....	3
Figure 1.2 Healing processes between fibers [10].....	4
Figure 3. 1 Evolution of bonding between fibers	10
Figure 3. 2 Viscosity versus temperature of PC	14
Figure 3. 3 Graphical representation of the elliptical shape of a deposited fiber	15
Figure 3. 4 Schematic of Deposition of FDM Fiber	16
Figure 3. 5 Thermal conductivity versus temperature for PC.....	19
Figure 3. 6 Specific heat capacity versus temperature for PC	20
Figure 4. 1 Configuration for image analysis samples	24
Figure 4. 2 Dimension for tensile testing sample	26
Figure 4. 3 Orientation of fiber	26
Figure 4. 4 MTESTQuattro Material Testing System	28
Figure 4. 5 Image of properly load samples	29
Figure 4. 6 Stress versus position graph exported from the MTESTQuattro software.....	30
Figure 4. 7 The Quanta 600F ESEM system	31
Figure 4. 8 Samples in the coating chamber	31
Figure 4. 9 Fixing the sample holder into the mounting hole of the SEM	32
Figure 4. 10 Setting scale for the imagej	33
Figure 5. 1 Predicted cooling at $T_o=543K$, $T_\infty=373K$	35
Figure 5. 2 Predicted bonding at $T_o = 543K$, $T_\infty = 373K$	36
Figure 5. 3 Predicted cooling at $T_o = 546K$, $T_\infty = 383K$	36

Figure 5. 4 Predicted bonding at $T_o = 546K$, $T_\infty = 383K$	37
Figure 5. 5 Predicted cooling at $T_o = 553K$, $T_\infty = 383K$	37
Figure 5. 6 Predicted cooling at $T_o = 553K$, $T_\infty = 383K$	38
Figure 5. 7 Image of the mesostructure of FDM sample	39
Figure 6.1 Response plot showing the effect of fabrication parameters on bond length..	42
Figure 6. 2 Response plot showing the effect of fabrication parameters on part strength	44
Figure 6. 3 Healing processes between fibers [10].	44

Table	Page
Table 4. 1 Experimental matrix for image analysis	24
Table 4. 2 Experimental matrix for tensile testing.....	25
Table 4. 3 Temperature and time setting for post-processing experiment.....	27
Table 5. 1 Comparision of predicted and actual bond lengths.....	39
Table 5. 2 Result of tensile tests conducted according to the L9 Taguchi matrix	40
Table 5. 3 Maximum tensile stresses of post-processed specimens	41
Table A. 1 Temperature dependent thermal conductivity data.....	53
Table A. 2 Temperature dependent specific heat capacity data.....	54

ABSTRACT

Fused deposition modeling (FDM) is the prominent manufacturing method for fabricating end-use parts due to the ability to build complicated structures. In order to be used confidentially in the industry requires a thorough understanding of mechanical behavior of FDM parts under working conditions. The strength of FDM parts is negatively influenced by the insufficient bond strength achieved between fibers, the weakest links in the FDM parts are the weak inter-layer bonds and intra-layer bonds. The aim of this study is to create models that can accurately predict bond length and bond strength between fibers. Analytical equations describing the sintering processes and heat transfer between FDM fibers and surrounding environment are developed and presented. By comparing the predicted value to the actual bond length, the models are found to be moderately accurate. To validate the relation between bond length and bond strength and also determine the process parameters that affect the bond strength, design of experiments (DOE) and analysis of variance (ANOVA) were applied. The result showed that the extrusion temperature to be statistically significant. Further research is recommended to take in to account more factors that could affect the cooling and sintering process that will help improve the precision of predictive models.

1. Introduction

1.1 Additive Manufacturing

There are numerous methods for fabricating components. The conventional manufacturing method constructed parts by removing material away from a solid block of material. In opposite to that, an emerging technology has been explored and become more favorable in manufacturing industry which is additive manufacturing.

Additive manufacturing(AM) has much more advantages than conventional manufacturing method. The highlight benefit of AM is the ability to build complicated geometries without any extra tools at very short time. In fact, to construct an object with complicated structure, traditional manufacturing takes days to complete, it also requires at least three cutting tools and professional machine users. In addition to that, cutting tool will be wear after limited uses that require replacement. On the other hand, AM takes hours to complete the same task, works without tooling and require no professional training to operate the machine.

Additive manufacturing builds objects by adding layer upon layer of material until the object is completely built. This can be accomplished by various methods such as SLS, SLA, FDM. Selective Laser Sintering (SLS) uses a laser beam to heat and melt thermoplastic powder into a continuous bonding layer. SLA on the other hand build object in a pool of resin. A laser beam is directed into the pool of resin, the trajectory of the beam following the same cross-section pattern of the object. Different to the other methods, fused deposition modeling (FDM) extruded melted polymer filaments through a heated extrusion