

contents

Introduction	<u>xi</u>
--------------	-----------

CHAPTER 1

Contribution of 3D Printing in Tooling and Portable Tools Application Case for a Smart Driller	<u>1</u>
---	-----------------

Introduction	<u>2</u>
---------------------	-----------------

3D Printing—Advantages and Drawbacks	<u>2</u>
---	-----------------

The Advantages	<u>3</u>
----------------	----------

The Drawbacks	<u>3</u>
---------------	----------

A Framework of 3D Manufacturing or Tools and Tooling	<u>3</u>
---	-----------------

Look for Tools or Tooling Equipment That Are Currently Compromised	<u>3</u>
--	----------

Think Function First	<u>4</u>
----------------------	----------

Minimize Over-Engineering and Post-Processing	<u>4</u>
---	----------

Example 1: Structural Design	<u>4</u>
-------------------------------------	-----------------

Functional Specifications	<u>4</u>
---------------------------	----------

Combine Functions and Complexity	<u>5</u>
----------------------------------	----------

Example 2: Functional Redesign	<u>5</u>
---------------------------------------	-----------------

Specifications	<u>5</u>
----------------	----------

The Result	<u>6</u>
------------	----------

Combine Functions and Complexity	<u>6</u>
----------------------------------	----------

The Result	<u>8</u>
------------	----------

Example 3: Design for Customization	<u>8</u>
--	-----------------

Specifications	<u>8</u>
----------------	----------

Combine Function and Diversity	<u>9</u>
--------------------------------	----------

Production	<u>9</u>
------------	----------

The Result	<u>9</u>
------------	----------

Application Case for a Smart Driller	<u>10</u>
---	------------------

The Specifications	<u>10</u>
--------------------	-----------

The Mechanical Design	<u>11</u>
-----------------------	-----------

Think Function First	<u>12</u>
----------------------	-----------

Optimization	12
Customization	13
The Production	14
The Result	14
Conclusion	16

CHAPTER 2

Design of a Brake Caliper Using Topology Optimization Integrated with Direct Metal Laser Sintering 17

Introduction	18
Motivation	19
Project Objectives	19
Design Methodology	19
Material Selection	21
Aerodynamic Analysis	21
Analysis of the Baseline Caliper	23
Optimization Process	24
Preprocessing	24
Optimized Solution Process	25
Post-Processing	25
Design of the Monoblock Caliper	26
Design of the New Monoblock Caliper Model B	28
Results of the Topology Optimization	31
Thermal Analysis	32
Manufacture	34
Results and Discussion	35
References	36

CHAPTER 3

Improving Heat Transfer and Reducing Mass in a Gasoline Piston Using Additive Manufacturing 39

Introduction	40
Piston Model Setup	42
Piston Engine Modelling	43
Heat Transfer Modelling	43
FEA Stress Analysis	46

Piston Crevice Volume	<u>48</u>
Piston Lightweighting	<u>50</u>
Internal Void above the Pin Bore	<u>50</u>
Void with 50% Material Density	<u>50</u>
Future Works	<u>53</u>
Summary/Conclusions	<u>54</u>
References	<u>54</u>
Acknowledgments	<u>55</u>
Definitions/Abbreviations	<u>56</u>

CHAPTER 4

Design and Manufacture of Titanium Formula SAE Uprights Using Laser-Powder-Deposition	<u>57</u>
Introduction	<u>58</u>
Upright Design	<u>58</u>
Design and Analysis	<u>58</u>
Preliminary Design	<u>58</u>
Finite Element Analysis	<u>59</u>
Laboratory Testing	<u>60</u>
Material Selection	<u>60</u>
Metallurgical Testing	<u>61</u>
Upright Manufacture	<u>62</u>
Process Capabilities Testing	<u>62</u>
Upright Manufacturing	<u>63</u>
Conclusion	<u>65</u>
Acknowledgments	<u>65</u>
References	<u>65</u>

CHAPTER 5

Method of Production of Composite Powder Cu-Ni Suitable for Use in Selective Laser Melting	<u>67</u>
Introduction	<u>68</u>
Experimental Setup	<u>68</u>

Experimental Results and Discussion	<u>69</u>
Summary	<u>70</u>
References	<u>71</u>
Acknowledgments	<u>72</u>

CHAPTER 6

Method of Producing Composite Powder EP648-Al₂O₃ for Selective Laser Melting Usage 73

Introduction	<u>74</u>
Experimental Setup	<u>74</u>
Starting EP648 and Al ₂ O ₃ Powders Characterization	<u>74</u>
Modification Parameters	<u>74</u>
Results and Discussion	<u>77</u>
Summary	<u>80</u>
References	<u>80</u>
Definitions/Abbreviations	<u>81</u>

CHAPTER 7

Selective Laser Melting of Copper by 200 W CO₂ Laser 83

Introduction	<u>84</u>
Experimental Setup	<u>84</u>
SLM Machine	<u>84</u>
Powder Characterization	<u>84</u>
SLM Processing Parameters	<u>84</u>
Porosity Characterization	<u>86</u>
Experimental Results and Discussion	<u>86</u>
Summary	<u>87</u>
References	<u>87</u>
Definitions/Abbreviations	<u>89</u>

CHAPTER 8**Direct Laser Metal Deposition of Al 7050 Alloy 91**

Introduction	<u>92</u>
Experimental Setup	<u>92</u>
Tensile Test Sample Preparation	<u>95</u>
Heat Treatment	<u>96</u>
Result and Discussion	<u>96</u>
Conclusion	<u>99</u>
References	<u>99</u>
Acknowledgments	<u>100</u>

CHAPTER 9**Study of the Influence of Electron Beam Treatment on the Surface Properties of the Material Produced by Selective Laser Melting 101**

Introduction	<u>101</u>
Experimental Setup	<u>102</u>
Experimental Results and Discussion	<u>103</u>
Summary	<u>104</u>
References	<u>104</u>
Acknowledgments	<u>105</u>
Definitions/Abbreviations	<u>106</u>

CHAPTER 10**A Hardness Study on Laser-Cladded Surfaces for a Selected Bead Overlap Conditions 107**

Introduction	<u>108</u>
Experimental Investigations	<u>109</u>
Hardness Measurement	<u>111</u>

Establishment of the FE Model	<u>111</u>
The Numerical Model of Heat Transfer in Laser Cladding	<u>113</u>
Boundary Conditions and Initial Conditions	<u>113</u>
Heat Source Model	<u>114</u>
Metallurgical Phase Transformation	<u>114</u>
Materials Properties	<u>115</u>
Meshing and Constraints	<u>115</u>
Results and Discussion	<u>117</u>
Hardness Results	<u>119</u>
Summary and Conclusion	<u>127</u>
References	<u>127</u>
Acknowledgments	<u>129</u>
Definition/Abbreviation	<u>130</u>
Appendix	<u>130</u>
About the Editor	<u>133</u>