Research on mechanical properties and microstructure by selective laser melting of 316L stainless steel

Pan Lu, Zhang Cheng-Lin, Wang Liang, Liu Tong and Li Xiao-Cheng

1 School of Aeronautics and Materials, Anhui Technical College of Mechanical and Electrical Engineering, Wuhu Anhui 241000, People’s Republic of China
2 School of Engineering Science, University of Science and Technology of China, Hefei Anhui 230026, People’s Republic of China
3 Anhui Top Additive Manufacturing Technology Co., Ltd Wuhu Anhui 241300, People’s Republic of China
4 HIT-Chungu Joint Research Center for Additive Manufacturing Materials, Anhui Chungu 3D Printing Institute of Intelligent Equipment and Industrial Technology, Anhui 241300, People’s Republic of China
5 Author to whom any correspondence should be addressed.

E-mail: ahjdpalu@126.com, jasen@tuobaokeji.com, ahjdjxt001@126.com and tongliu1988@126.com

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Abstract

Selective Laser Melting (SLM) and Selective Laser Remelting (SLR) were employed to fabricate 316L stainless steel in this work. Mechanical properties, microstructure were investigated. The results showed that scanning speed had little effect on Young modulus, but large effect on yield strength, tensile strength, elongation and surface roughness for SLM. Additionally, young modulus, tensile strength, elongation, and relative density changed from 3.8 GPa to 14.3 GPa, 667 MPa to 725 MPa, 37.3% to 40.8%, 91.6% to 99.3% for SLM and SLR process, respectively, so the mechanical properties, including strength and plasticity of 316 L stainless steel can be improved by suitable Selective Laser Remelting process. In addition, fracture characteristics, strengthening mechanisms, and crack propagation types were studied by SEM, EDS. The results showed that excessive surface roughness, low metallurgical bond between layers, internal defects (balling, liquid splashing, pores, bubbles, etc) and low atomic binding force lead to crack propagation and decreased mechanical properties.

1. Introduction

Metal 3D printing technology mainly includes laser and electron beam printing technology. The technology of manufacturing metal functional parts directly includes Selective Laser Sintering (SLS), Direct Metal Powder Laser Sintering (DMLS), Selective Laser Melting (SLM), Laser Near Net Forming (LENS), Electron Beam Selective Melting (EBSM) and so on [1]. In recent years, new technologies for metal 3D printing have shown explosive growth. In 2017, Imperial College developed Electro-Chemical Augmentation Manufacturing (ECAM) metal 3D printing process [2], and ExOne developed binder jetting (B J) technology in 2017 [3]. Fabrisonic company developed ultrasonic 3D printing (Ultrasonic Additive Manufacturing, UAM) in 2017 [4]. Ink-jet Metal Printing (Nano Particle Jetting, NP) was developed by XJet, Israel [5]. All 3D printing technology showed unique technical solutions [6].

Selective Laser Melting (SLM) is a mature technology in metal 3D printing, and it has great potential in strength, precision and compactness. SLM adopts powder laying mechanism, metal powder melted by high energy laser layer by layer in build-up direction. After absorbing laser energy, metal powder temperature rises sharply and reaches melting point, and solidifies sharply after laser moved. SLM is suitable for fabrication of complex structures, small sizes and high-precision parts with a relative density close to 100%, size precision reaches 20 μm~50 μm, surface roughness reaches 20 μm~30 μm, and has rapid development in the fields of mechanical, medical, aerospace and military [7, 8].

Selective Laser Melting has been used to fabricate titanium alloy [9], ceramic material [10], copper-based metal [11], tool steel [2], aluminum alloy [12, 13], nickel alloy [14], stainless steel [15] and other advanced materials, as well as amorphous glass, gradient materials [16]. The researches of SLM mainly focused on laser
process parameter optimization, structure size optimization, defect analysis, mechanical properties test and so on. SLM study on 316 L Stainless Steel is still developing. However, it has not been completely investigated on behavior of low mechanical properties with grain refinement. Yin et al [11] observed the microstructure characteristics of 316 L stainless steel at different locations by SLM, the results showed that the microstructure was mainly cellular. H Attar et al [17] reported that incompletely melted particles and porosities caused early fracture in porous sample. He et al [18] pointed out that the size of the surface roughness and non-uniformity would form stress concentration area in the processing surface, inducing crack initiation, eventually lead to the change of mechanical properties. Liu et al [19] analyzed the influence of the parameters on the relative density and tensile properties of 3D parts, and the optimized processing parameters were obtained. Song et al [20] researched on tensile properties of cold rolled 316 L stainless steel at different temperatures. Tan et al [21] obtained the mechanical properties of hot rolled 316 L stainless steel by tensile test. Qian et al [22] pointed that nano hardness of the porous aluminum alloy changes with the laser power, while the the elastic modulus does not change obviously by Selective laser Melting. H Attar et al [23] observed that the differences in microstructure were mainly associated with differing rates of cooling and differing energy densities during SLM and LENS processing. Pan et al [24, 25] studied the morphology, chemical composition, type of precipitated phase, grain size and the microstructure, obtained formation mechanism of cracks at different positions. Shahir et al [26] investigated the porosity and micro hardness of 316 L stainless steel samples fabricated by selective laser melting. Li et al [27] pointed out that surface roughness first decreased and then increased with the increase of line energy density, and surface roughness increases with the increasing laser scanning distance and scanning speed.

In this paper, the mechanical properties of 316 L stainless steel fabricated by SLM were further investigated, including the fracture characteristics, failure forms and process parameters effects on stiffness, strength and plasticity. In addition, compared with cold roll process, fracture, defects, grain size, phase and surface roughness were studied.

2. Materials and methods

2.1. Powder properties and chemical composition

Air atomized 316 L stainless steel powder is selected for SLM. The average particle size is 22 μm–55 μm. There are a small amount of satellite powder, irregular powder and hollow powder. The morphology of powder is shown in figure 1.

The chemical composition of 316 L stainless steel metal powder by EDS is shown in table 1. 316 L stainless steel is austenitic stainless steel and its thermal conductivity is about half of that of low carbon steel, but the coefficient of linear expansion is about 50% higher than that of low carbon steel, so the forming process of SLM is more likely to produce defects, including bubbles, cracks, spatters, unmelted and partially unmelted powder and oxide inclusions [28, 29].

After the fabrication of the metal 3D parts, they are first rough ground on the grinder, then sent to the wire cutter to cut the parts off the substrate. The 3D parts are then polished with sandpaper and corroded.
2.2. Equipment and experiment parameters

All 3D samples were fabricated by desktop metal printer developed by Anhui Top Additive Manufacturing Technology Co., Ltd, as shown in figure 2. The device is equipped with an optical fiber device (wavelength 1064 nm, power 250 w), the forming platform is 100 mm × 100 mm, and the spot diameter is 70–200 μm and continuously adjustable.

Figure 3 shows laser scanning mode and forming schematic diagram. As shown in figure 3(a), the chessboard-based directional scanning strategy is adopted to ensure melting stacking range [30]. Scanning line hatch space is 0.11 mm, layer thickness is 30 μm, angle between black-and-white chessboards is rotated 90°, angle of laser line is 67° and angle between Z-direction layers is 67°.

Forming process is a complex dynamic non-equilibrium process, and heating and cooling speed reached $10^4 \text{K S}^{-1}$, typical non-equilibrium heating and cooling [31, 32]. Molten pool and the temperature field are extremely unstable, and the phenomena of heat transfer, melting, phase change, vaporization and mass transfer always exist. When the laser spot leaves, original tiny molten pool will be cold and melting and solidification of metal powder is less than a few milliseconds, so it is easy to produce defects such as spheroidization, pores, bubbles and cracks [33–35].

As shown in figure 3(b), forming schematic diagram mainly include the overlaps between the melt channels on the X-Y plane and overlaps between the Z-direction layers. The process parameters influenced weld pool size, powder melting state and overlap rate.

To study the effect of laser power on mechanical properties, five categories of laser process parameters (ten samples) were selected, Power 200 w, Hatch distance 0.11 mm, Layer thickness 30 μm, shown in table 2. Figure 4(b) showed the layout of the sample on the substrate and 3D parts.

2.3. Tensile test method

The tensile test was carried out according to ASTM E8/E8M-16a. Tensile rate was 5 mm min$^{-1}$, using a combined universal testing machine.

Tensile specimen is shown in figure 5. The specimen specifications are as follows: original distance $L_0 = 40$ mm, parallel length $L_c = 50$ mm, cross-sectional shape is round, the original diameter is $d_0 = 10$ mm, and the sample is non-proportional. The sample is not machined and used directly after forming with SLM.

Table 1. Chemical composition of 316 L stainless steel used in SLM forming.

| Element | C   | Si  | Mn  | P   | S   | Ni      | Cr      | Mo   |
|---------|-----|-----|-----|-----|-----|---------|---------|------|
| 316 L   | $\leq$0.03 | $\leq$1.00 | $\leq$2.00 | $\leq$0.035 | $\leq$0.03 | 10.0–14.0 | 16.0–18.0 | 2.0–3.0 |

Figure 2. TB-SLM100S desktop metal printer.
Figure 3. Checkerboard scanning mode and forming schematic diagram. (a) Checkerboard scanning Mode (b) Selective laser melting forming schematic diagram.

Table 2. Experimental density data of different laser scanning speed.

| NO. | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|-----|------|------|------|------|------|------|------|------|------|------|
|     | 800  | 800  | 900  | 900  | 1000 | 1000 | 1100 | 1100 | 1200 | 1200 |
|     | 75.75| 75.75| 67.34| 67.34| 60.6 | 60.6 | 55.09| 55.09| 50.5 | 50.5 |
|     | 91.6 | 88.1 | 87.1 | 89.8 | 90.9 | 87.9 | 86.1 | 86.9 | 86.4 | 86.8 |

Figure 4. Layout of the samples on the substrate and 3d parts.(a)layout of the samples;(b)3d parts.
2.4. Remelting strategy

When the laser energy is too low, some of the powder can not be melted completely. The powder is overburned when the laser energy is too large. As shown in figure 6, two-step remelting process were applied, and the same layer are used to re-exposed twice: first Step is used to adopt conventional laser process parameter, low laser power (high scanning speed) were applied on the second-step. Laser remelting has the potential possibility to change the microstructure and improve the mechanical properties, including strength and plasticity.

In this paper, remelting process parameters were shown in table 3, five categories of laser process parameters were selected: Hatch distance 0.11 mm, Layer thickness 30 μm, and scheme 5 is no-remelting process.

2.5. Characterization

Optical microscope was used for microstructure, the etching solution was 4% nitric acid for 5 s. Samples were cleaned by ultrasonic cleaning instrument and alcohol. The density test is based on Archimedes principle by multifunctional density tester (ar-300me, accuracy 0.001 g cm$^{-3}$).

Morphology was observed by SEM (Hitachi SU8010), and Oxford instrument EDS (AZtec X-Max50) was used for composition analysis, and Joint universal testing Machine (Model DSC-10) was used for tensile test, surface roughness meter (TESA rugosurf 10-G) was used for surface roughness [36, 37].

| NO. | First-step Power/W | Scanning velocity mm s$^{-1}$ | Volume energy density J mm$^{-3}$ | Second-step Scanning speed mm s$^{-1}$ | Volume energy density J mm$^{-3}$ | density Kg m$^{-3}$ | Relative density % |
|-----|------------------|-----------------------------|-----------------------------|----------------------------------------|-----------------------------|----------------------|------------------|
| 1   | 200              |                             |                             | 950                                    | 87.719                      | 7.925                | 99.31            |
| 2   | 250              |                             |                             | 1187.5                                 | 87.719                      | 7.896                | 98.94            |
| 3   | 250              | 950                         | 109.64                      | 760                                    | 109.64                      | 7.903                | 99.06            |
| 4   | 250              | 950                         | 109.64                      | 950                                    | 109.64                      | 7.901                | 99.01            |
| 5   |                  |                             |                             |                                        |                             | 7.916                | 99.19            |
3. Result

Figure 7 shows the macro-physical diagram of the 3D parts after breaking. The fracture position fluctuates randomly, the fracture surface is straight, and the fracture is instantaneous.

3.1. Evaluation of mechanical properties

3.1.1. Mechanical properties of tensile test

The stress-strain diagram of 316 L stainless steel prepared by cold-rolled [15, 16] and selective laser melting and cold rolling process are shown in figure 8.

As shown in figure 8, sample 6 and 7 for stress-strain diagram belong to brittle materials, and samples 1 and 2 belong to typical plastic materials. The plasticity and brittleness of the material change with the laser processing parameters. So process parameters affect the continuity of the microstructure and the numbers of defects. Linear energy density of samples 3 and 4 is smaller than that of sample 1 and 2.

The average value of Young modulus, Yield strength, Tensile strength and elongation after fracture for each of the process parameter sets were shown in figure 9.

(1) Elastic modulus: Compared with cold rolled 316 L stainless steel, elastic deformation of 3D-parts is smaller, down to 15 ± 3%, and Young modulus fluctuates between 3.5 ± 0.1 GPa to 3.8 ± 0.1 GPa. As shown in figure 8, stiffness of all 3D parts is close to each other, so laser scanning velocity (changing from 800 mm s$^{-1}$ to 1200 mm s$^{-1}$) led to little effect on Young modulus.
Young modulus of cold rolled process for 316 L stainless steel is 200 ± 20 GPa. So with extreme heating and solidification by SEM, phase transition process reduces the bonding force between atoms, leading large decrease of Young modulus between 3.5 ± 0.1 GPa to 3.8 ± 0.1 GPa.

2) Yield strength: there is no obvious yield stage in stress-strain curve, as shown in the figure 7. In figure 8, yield strength fluctuates between 0.62 ± 0.02 GPa to 0.64 ± 0.02 GPa with 0.2% strain. Compared with cold rolled process 0.35 ± 0.01 GPa, the effect of process parameters on yield strength of metal 3D printing parts is obvious.

3) Tensile strength: compared with rolled parts, there is no obvious stress strengthening stage in SLM. The size of grain and number of defects directly determined the tensile strength of 3D parts. Tensile strength of 3D-parts fluctuated between 0.56 ± 0.01 GPa to 0.67 ± 0.01 GPa. Considering that the 3D parts did not undergo isostatic pressure and other heat treatments, it is possible to improve the tensile strength of SLM forming parts further.

4) Elongation after break: as shown in figure 7, elongation after break of rolled 316 L stainless steel is 50 ± 2.5%, and elongation after break of 3D parts fluctuates between 4.2 ± 0.05% to 37.3 ± 2.5%. Therefore, the plasticity of SLM process is lower than that of rolling process.

3.1.2. Surface roughness
Surface roughness is measured by surface roughness meter (TESA rugosurf 10-G), as shown in figures 10 and 11. Upper surface roughness is generally higher than the side roughness in waves by SLM. End surface roughness is mainly caused by unstable weld splicing, which is caused by balling effect. And the side roughness is mainly caused by partial melting and balling of the sample powder after adsorption [38, 39]. Compared with the surface roughness of cold rolling process 1 μm, surface roughness of SLM technology is significantly higher. Large and inhomogeneous surface roughness resulted in stress concentration, induce crack initiation, and eventually lead to changes in mechanical properties.

3.1.3. Remelting process mechanical properties
The stress-strain diagram of 316 L stainless steel prepared by remelting process of selective laser melting in figure 12.

The average value of Tensile strength, Yield strength, Elastic modulus and elongation for each of the process parameter sets were shown in figure 13. Compared with SLM process, tensile strength increased from 674 MPa to 725 MPa, and Yield strength increased from 591 MPa to 643 MPa. In addition, elongation increased from 39.4% to 40.8%. The strength and plasticity of 316 L stainless steel are improved by suitable remelting process.
Figure 10. Surface roughness.

Figure 11. Surface roughness of sample one. (a) side surface (axial); (b) upper surface.

Figure 12. Stress-strain diagram of 316 L stainless steel by remelting process of selective laser melting.
3.2. Microstructure analysis

3.2.1. Morphology of metal 3D printed specimen

Figure 14 showed SEM morphology at the cross sections (cross section far away from fracture) of samples 2 and 6. Compared with sample 2, linear energy density of sample 6 was too low and the wetting degree of the metal powder is insufficient, resulting in pores caused by the incomplete melting metal powder, powder spatter and balling. With the increase of energy, pores gradually decrease [40, 41].

3.2.2. Surface morphology of metal 3D parts

As shown in figure 15, there is a large difference between end face and side surface of 3D parts. As shown in figure 15(a), there are obvious grooves and a small amount of unmelted powder on the surface of the interface weld channel, suggesting that the melt pool was unstable [42]. Figure 15(b) shows that the boundary between the 3D printed deposit layers in Z- build-up direction is obvious, showing irregular curve shape, cracks, unmelted powder and liquid spatter, etc. Side cracks are the source of crack in tensile fracture.

As shown in figure 15, balling results in defect including porosity. After solidification, the metal spheres are independent of each other. In the process of layer-by-layer scanning, there are a large number of pores between

Figure 13. The tensile properties of 316 L stainless steel fabricated by remelting and no-remelting process by SLM.

Figure 14. Cross-sectional morphology. (a) sample 2; (b) sample 6.
the metal spheres, resulting in high porosity and decreased mechanical properties. On the other hand, balling of
the surface will hinder the normal work of the powder roller, increasing the friction between the powder
scraping and the surface, which will not only affect the surface quality of the metal [43].

3.2.3. Microstructure of metal 3D parts
Pan et al [24] studied grain size of 316 L stainless steel 3D parts by EBSD, and grain size was about 10–20 μm. In
addition, cells appeared in weld, as shown in figure 17. In SLM process, due to the high cooling rate, the super-
cooling degree of the front on solid-liquid interface is relatively high. When solidifying, the heat flow direction is
along build-up direction, and there would be a high enough temperature gradient at the front of solid-liquid
interface to ensure that SLM process is a controlled directional solidification and the solidification process is the
growth of dendrites. Figure 16 showed the diagram of solidified dendrites growth.

As shown in figure 17, dendrite-cells appeared around melt pool cent, and dendrite-cell size is about 1 μm.
Dendrite-cells with misorientation 5°–30° appeared in the molten pool sides, and smooth surface appeared in
interlap between welds.

3.2.4. Fracture morphology of 3D parts
Figure 18 showed the cross-sectional morphology of fracture surfaces. The fracture surfaces are uniform and
bright, without necked macroscopically. 3D parts broken along 45° at the cut-off port, but almost horizontal,
which belongs to typical brittle fracture. However, there are local spalling on the outside and inside of the
specimen, necking and ductile fracture inside 3D parts. For tensile tests, all 3D parts broken directly at the
junction of the layers in the build-up direction, as shown in figure 19.

As shown in figures 20 and 21, there are mainly two kinds of fracture forms in fracture surfaces, which are
different from the cold rolled process. That is, sector cleavage pattern (figures 20(b) and 21(b) and dimple
pattern (figures 20(c) and 21(c). In addition, there are unmelted powder, liquid spatter, balling and cracks in
Figure 17. Weld microstructure of the upper surface.

Figure 18. Macro-morphology of fracture surfaces of typical tensile parts. (a) sample 2; (b) sample 3.

Figure 19. Internal and interface morphology of fracture surface.
fracture surface. Due to pores in 3D printing and the defects such as cracks, balling, incomplete melting of powder and spatter, internal structure and phase structure of the printed parts are not continuous, so brittle fracture occurs immediately along the weak point at the junction of the layers in the build-up direction, with external force [44].

To further analyze the distribution of internal composition of fracture surface, typical positions in the fracture surface are selected, as shown in figure 22, and the chemical composition of each location is shown in table 3.

Table 4 shows that carbon content in the fracture is generally too high and the plasticity and toughness decrease sharply, resulting in brittle break in 3D parts. The chemical composition of point 1 is basically the same as that of the original powder, with a spherical morphology and a diameter of about 10 μm. This defect is an incomplete melting powder defect. The morphology of the holes is aggregation at point 2, smooth surface at point 3, dimple morphology at point 4 and micro-crack at point 5.

So, tensile fracture of 3D parts fabricated by selective laser melting mainly includes four kinds of propagation forms: (1) With the increasing of the tension, there is a weak crack at the junction of the layers in the build-up direction. Stress concentration leads to crack propagation; (2) Crack extends to the internal micro-crack to form brittle scallop pattern; (3) Crack continues to propagate to the unmelted metal powder, and the crack extends along the outer part of the powder to form a smooth surface. (4) When the crack reaches the defect-free place, stress fluctuation increases, plastic local necking occurs and then fracture forms the dimple. Crack propagation changes with the micro-crack, unmelted powder and defect-free, and so on. Crack propagation shows different tearing patterns, including brittle scallop pattern, plastic dimple pattern and smooth surface pattern alternately.
3.2.5. Remelting microstructure of metal 3D parts

Figure 23 shows the upper surface morphology of the remelting process and the unremelted process samples with no corrosion and after corrosion. Figures 23(a) and (b) showed the remelting process makes the melting channel smoother and the unmelted powder is basically disappeared. Figures 23(c) and (d) showed that Overlaps of welds for remelting improved to be closer than no-remelting, and remelting reduced the number of pores and holes. Therefore, laser re-melting does not only improve the surface quality on the top surfaces, but also reduces the defects such as spheroidization. This is one of reasons of why remelting process improved both Strength and plasticity.

Figure 24 shows the side surface morphology of the remelting process and the unremelted process samples. The interlaps between the molten pools of remelting process is smooth, and molten pools have connected to each other smoothly. So, connection between welds are more stable. This is another reason of why remelting process improved both Strength and plasticity.

4. Discussion

It is proposed in literature [40, 41] that too low Young modulus appeared in porous structure, while the Young modulus of solid 3D parts is 150 GPa and even 400 GPa [45]. In the next step, further adjustment of process parameters is required to obtain optimized products. Considering testing the desktop printer assembled in this paper, results reflected that the stability of desktop printer had great effect on 3D parts, equipment parameters, especially laser power parameters need to be further optimized.

In summary, the fracture surface of 316 L stainless steel fabricated by selective laser melting is smooth and bright, which is different from that of cold rolled process. The fracture is mainly due to the cracks caused by the fusion between layers in the process of high energy laser beam accumulation. The internal defects such as unmelted powder and balling lead to the discontinuity of the internal structure of the samples, and the crack propagation is caused by stress concentration at cracks, where the original strength is much lower than the theoretical strength.

Notably, several interesting results were found out, even though they were not consistent with the expectation. In literature [37, 40], upper surface roughness was lower than the side roughness, but upper surface roughness is higher than side roughness in our research, which may be due to the serious spatter phenomenon, resulting in the instability of the weld, and the low bond rate leads to uneven weld joints. In addition, low Young modulus is a distinctive phenomenon we found in SLM process.
5. Conclusions

This article mainly carried out two aspects of research: on the one hand, mechanical properties of 316 L stainless steel SLM and SLR process samples were obtained by tensile test, including modulus of elastic, yield strength, tensile strength, elongation and surface roughness. The following conclusions were drawn from the results and discussions.

Figure 23. Remelting and no-remelting upper surface morphology of sample parts. (a) Remelting NO. 1; (b) No-remelting NO. 5; (c) Remelting NO. 1 after corrosion; (d) Remelting NO. 5 after corrosion.

Figure 24. Remelting and no-remelting side surface morphology of sample parts. (a) Remelting NO. 1; (b) No-remelting NO. 5.
(1) SLM and SLR process changed the mechanical properties of 316 L stainless steel. Compared with cold-rolled process, there were no obvious yield stage and stress strengthening stage for 3D parts. Laser process parameters had little effect on the stiffness, and the modulus of elastic is about 3.8 GPa for SLM and 14.3 GPa for SLR, but laser process parameters had great influence on strength and plasticity of 3D parts: The tensile strength and yield strength of the 3D parts without heat treatment reached 725 MPa, and 643 MPa by Selective Laser Remelting, respectively. The plasticity of the samples was generally lower than that of rolled 316 L stainless steel.

(2) Internal structure and phase structure of 3D parts were not continuous, crack source s was the weak overlaps between layers along build-up direction, fracture surface was smooth and bright in X-Y plane. The internal defects expanded in four forms by external force. There were brittleness fan pattern, plastic dimple pattern and smooth surface, and un-melted powder, balling, liquid spatter and crack in fractures.

(3) SLR process improves both the plasticity and strength of 316 L stainless steel. Reasons can be listed as below: remelting process decreased the unmelted powder, furtherly, reduced defects, such as balling. And on the other hand, the remelting process makes the interlaps of the molten pools smoother, and the connection between welds is more stable.

(4) The results of why grain refinement without improving the mechanical properties were mainly explained from the following four aspects: 3D parts have obvious and uneven side surface roughness, up to 24 μm, which causes stress concentration and reduces mechanical properties; In build-up direction, metallurgical bond between layers is not sufficient, leading to generate crack source, resulting in the decrease of mechanical properties; Composition segregation and stress concentration caused caused by internal defects (balling, liquid splashing, pores, bubbles, etc), resulting in the decrease of mechanical properties; Rapid solidification of SLM leads to reduced atomic binding force, thus reducing young modulus.

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Author Contributions

Conceptualization, Pan Lu and Zhang Cheng-lin; Methodology, C L Z; Software, Li Xiao-cheng; Validation, Pan Lu. and Zhang Chen-lin; Formal Analysis, Liu Tong; Investigation, Pan Lu. and Zhang Chen-lin; Resources, Pan Lu, Zhang Chen-lin and Liu Tong; Data Curation, Pan Lu; Writing-Original Draft Preparation, Pan Lu; Writing-Review & Editing, Pan Lu. and Zhang Chen-lin. The authors would also want to express thanks to Master Wang Liang for help on mechanical testing in the experiment.

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Conflicts of Interest

The authors declare no conflict of interest.

ORCID iDs

Pan Lu  https://orcid.org/0000-0001-8353-454X

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