3D-printing and consolidation of 316L stainless steel powder components

UCSD Jacobs | Mechanical and Aerospace Engineering

Student: Ifeanyichukwu D. Olumor
Advisors: Prof. Eugene A. Olevsky (SDSU) and Prof. Marc A. Meyers (UCSD)
SDSU-UCSD Joint Doctoral Program in Engineering Sciences

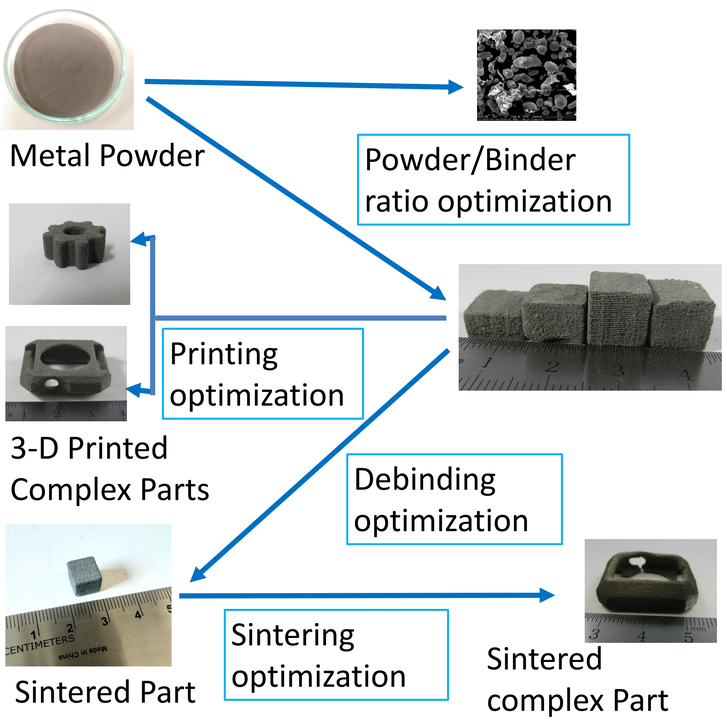
San Diego State University

OVERVIEW

ABSTRACT

A unique binder jetting method is employed in printing 316L stainless steel components with the aim of improving both the green density of printed parts and subsequently sintered components. In this method, a water-soluble binder is premixed with 316L stainless steel powder before printing. During printing, water is jetted unto the powder/binder mixture to selectively activate the binder, layer by layer. The effects of printing parameters on the green density and sintered components are investigated. Results show that layer height and nozzle temp affect the density and dimensional accuracy of the green compact. Results show that on reducing layer height, green density increases. However, the dimensional accuracy of the printed samples decreases, especially in the Z-direction.

3D Printing (Binder Jetting) / Sintering Processing steps



Optimization of 3-D printing of green parts → Consideration of green density and geometric accuracy

90% stainless steel	Relative Density
SET A (Layer height:250 µm)	28.9%
SET B (Layer height:200 µm)	29.4%
SET C (Layer height:150 µm)	32.0%
SET D (Layer height:100 µm)	35.2%

95% stainless steel	Relative Density
SET A (Layer height:200 µm)	33.4%
SET B (Layer height:150 µm)	39.0%
SET C (Layer height:100 µm)	37.9%

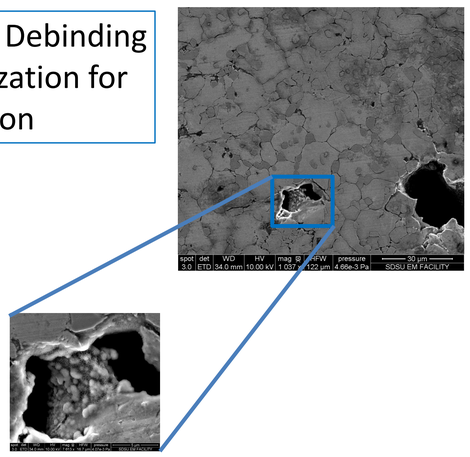
95% stainless steel	Relative Density
SET A (Water temp:50)	33.4%
SET B (Water temp:70)	39.0%
SET C (Water temp:90)	37.9%

Printing parameters
Z-level Home: 2.5
Water temp: 50
Roller speed: 70
Shaking speed: 60

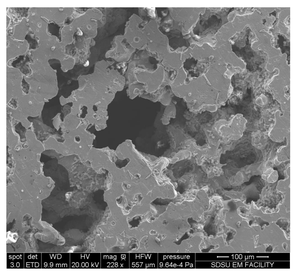
Layer height: 200

Sintering of 3-D Printed SS 316L Samples

Before Debinding optimization for oxidation

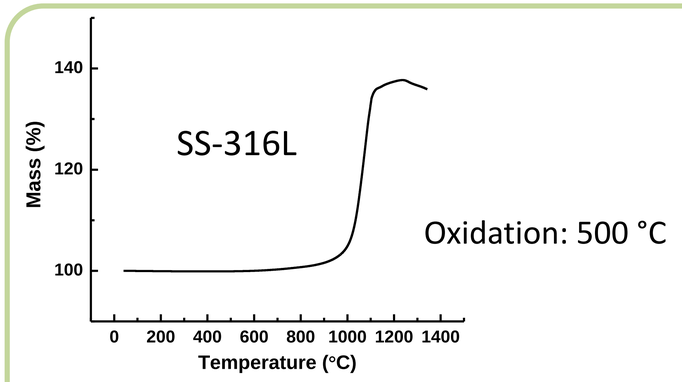


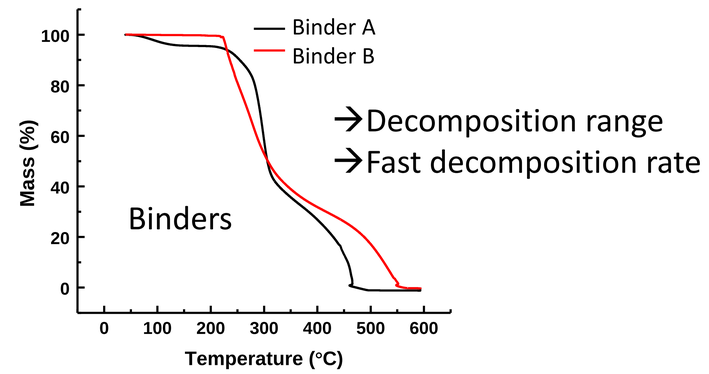
Sintering Temperature (°C)	Relative Density
1250	38.99%
1320	38.88%
1360	70.08%
1380	65.64%
1400	73.16%

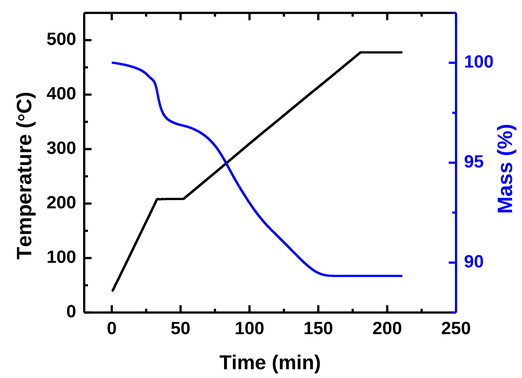


After Debinding optimization for oxidation

Optimization of debinding for SS316L green parts → Oxidation consideration







Green SS316L Printed parts

→ Complete decomposition of binders
→ No oxidation

References

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2. Bai, Y. and C.B. Williams, *An exploration of binder jetting of copper.* Rapid Prototyping Journal, 2015. 21(2): p. 177-185.
3. Doyle, M., et al., *Effect of Layer Thickness and Orientation on Mechanical Behavior of Binder Jet Stainless Steel 420+Bronze Parts*, in *43rd North American Manufacturing Research Conference, Namrc 43*, A.J. Shih and L.H. Wang, Editors. 2015. p. 251-262.