FMRI RET 2017- Binder-Jet Printing of Bimodal Powders

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Abstract

The metal products produced by the binder jetting process are cost-effective and accessible but unfortunately the products have a reduced density when compared to their counterparts that are manufactured traditionally. Three different bimodal 316 stainless steel powder mixtures of 48μ-65μ powder and <25μ powder were created at 1:7 ratio, 1:4 ratio and 7:20 ratio. Bulk density, tap density and spread density were investigated for each of the different ratios of bimodal powder mixtures.

Background

Additive manufacturing (AM), more commonly known as 3D printing, is a technology that has seen use in various studies for different applications[1]. Binder Jetting (BJ) is a type of additive manufacturing process that fabricates metal products by selectively ink-jetting a binder into a power bed, which Is followed by post-sintering. (Fig.1)

The main challenge in creating metal products using BJ is achieving a product that is fully dense. [2] To minimize porosity, which would increase density, bimodal powder mixtures are used. A proper ratio of multiple-sized powders could be utilized to fill the unused empty spaces.[3] Bulk density, tap density and spread density were measured for the different ratios of bimodal powder mixtures.

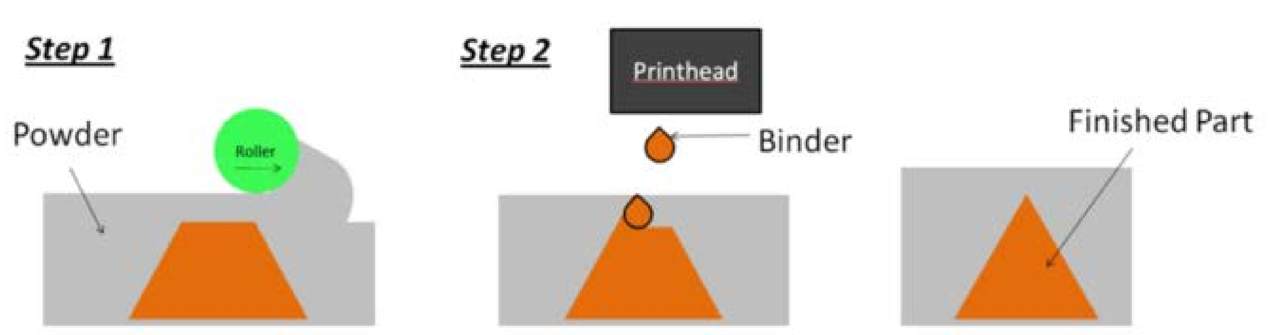

Fig. 1: Process of AM with BJ Process[2]

Objectives

- Prepare three different bimodal 316 stainless steel powder mixtures at varying ratios.
- Understand how bimodal powder mixtures at different ratios affect bulk density, tap density and spread density.

Approach

1. Sieves was used to separate target sizes: 48μ-65μ and <25μ.
2. 48μ-65μ sized powder was mixed with <25μ sized powder at three different ratios (1:7[14%], 1:4[25%] & 7:20[35%]) and mixtures were tumbled for 30 minutes.

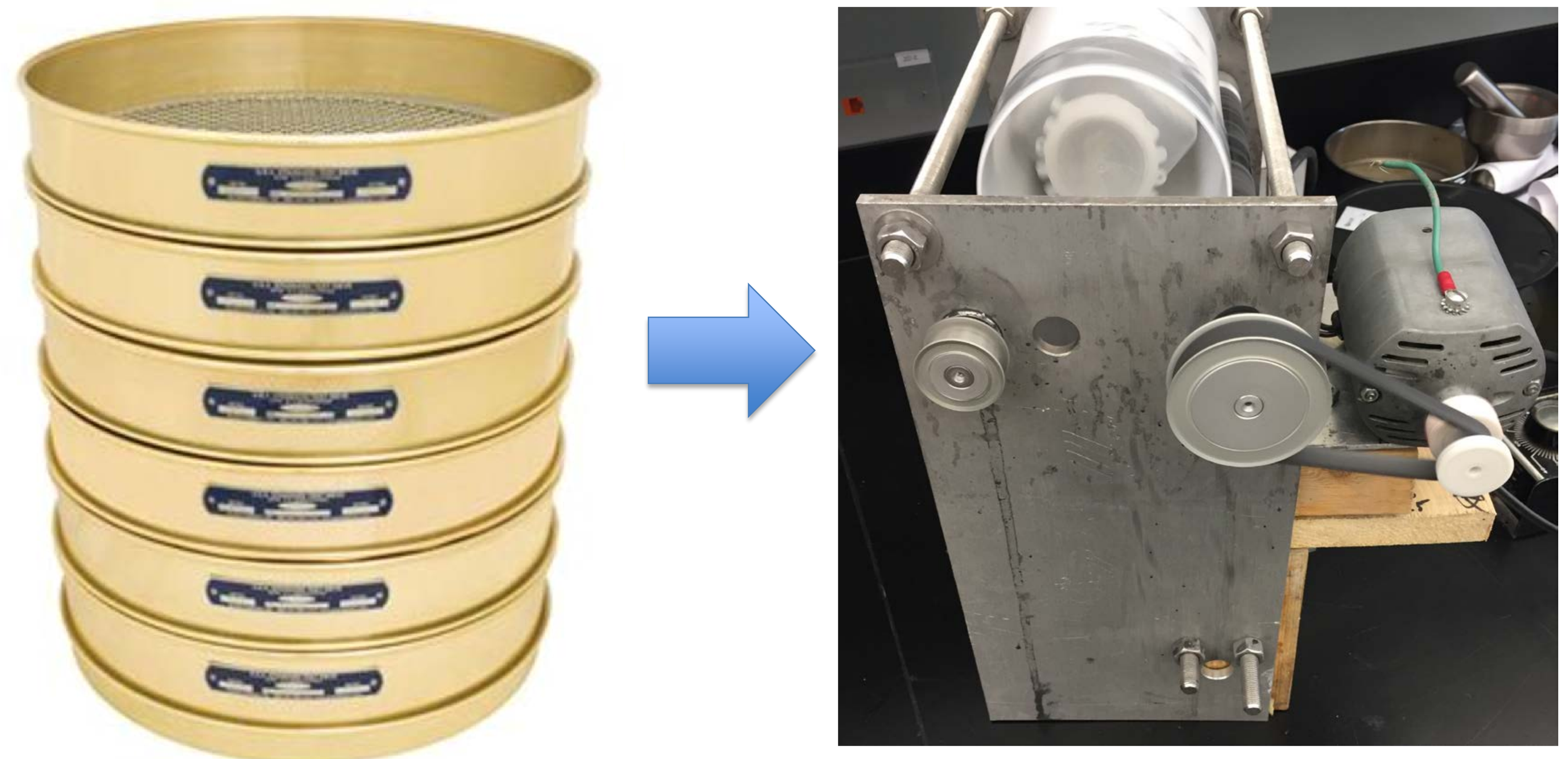

Fig. 2: Bimodal powder mixtures procedure using 316L stainless steel coarse powder.

3. Bulk, tap and spread densities were measured for each of the powder mixtures.

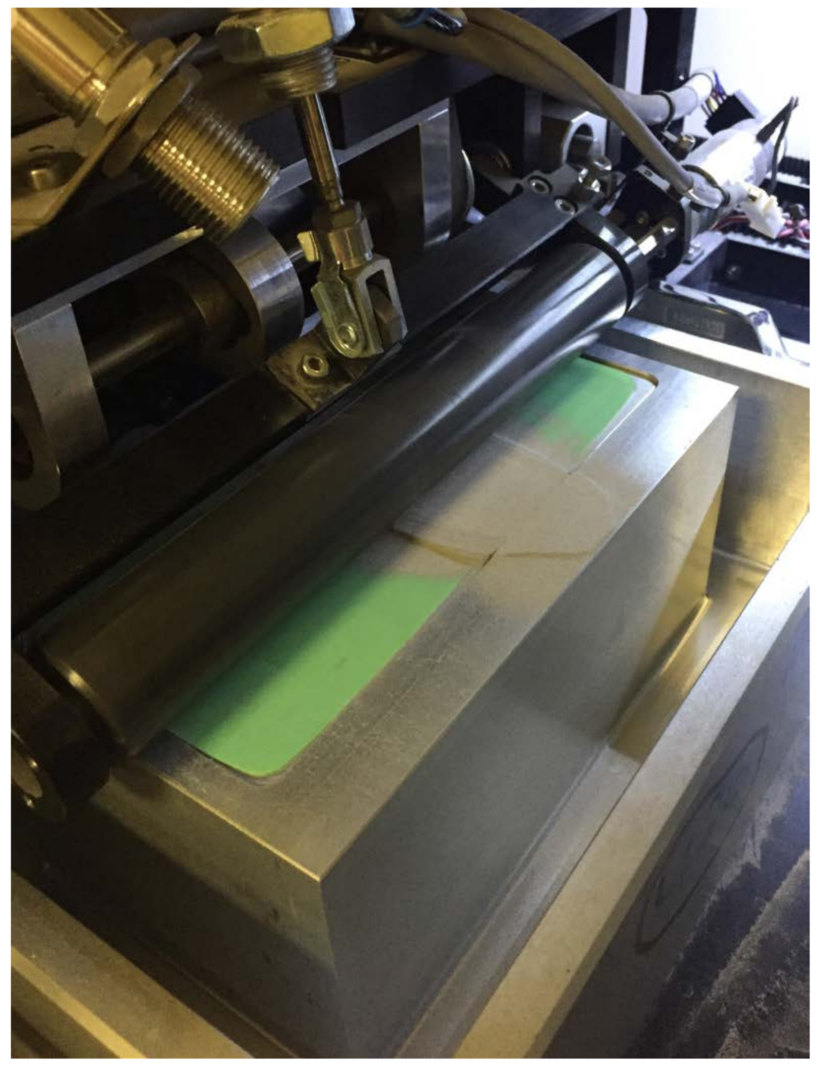

Fig. 3: ExOne Innovent 3D printer was used to spread powders.

Conclusions

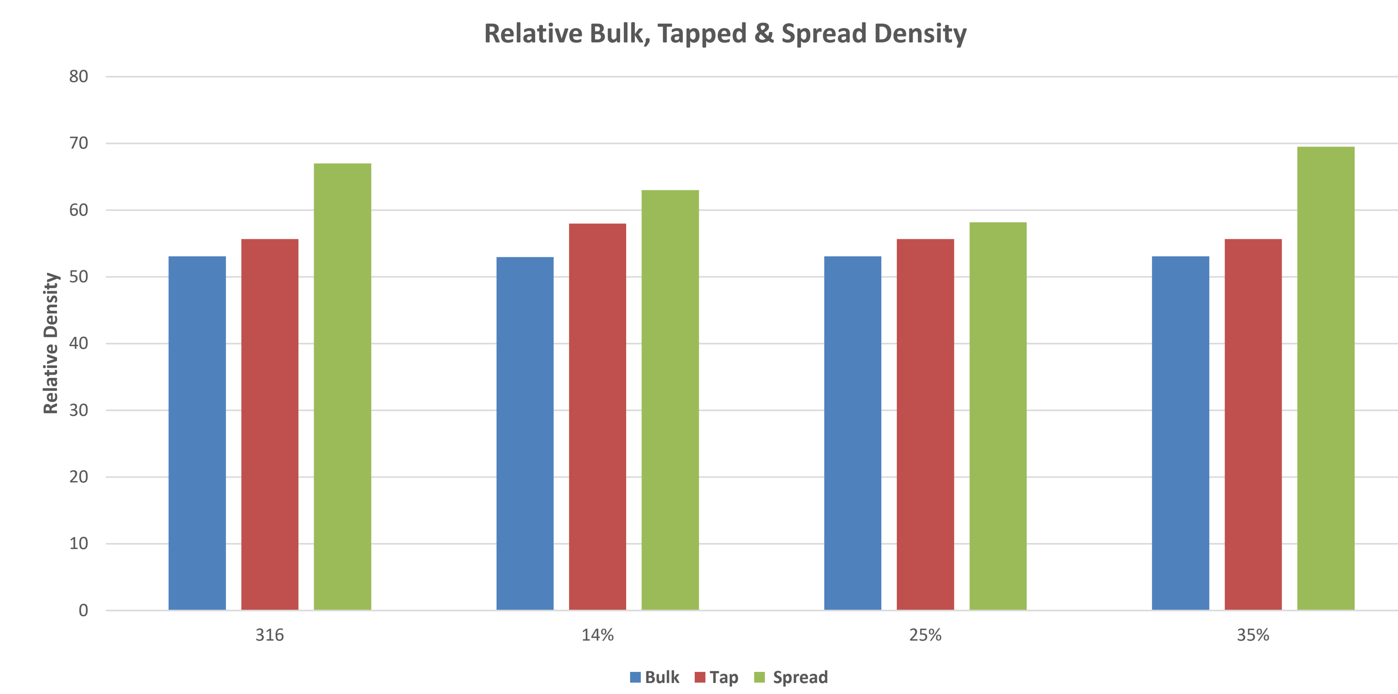

Fig. 4: Relative bulk, tapped and spread density for the raw 316 coarse and processed powders. To determine relative density percentage each of the obtained densities were divided over true density of 316, 7.99g/cm^3.

As the percentage of fine powders increased in the bimodal powder mixture, the bulk and tap density increased as well. Spread density seemed to decrease as percentage of fine powders increased. This changed for the 7:20(35%) mixture, which had the highest relative density at 69.51%.

The data gathered has provided interesting insight into the effects of bimodal powders on relative bulk, tap and spread density. Further data is needed on bimodal powder mixtures effect on sintered density. Also, a more measureable method should be used to tumble the mixture to ensure thorough mixing.

Referenced Resources

1. Ziaee, M., Tridas, E. M., & Crane, N. B. (2016). Binder-Jet Printing of Fine Stainless Steel Powder with Varied Final Density. Jom,69(3), 592-596. doi:10.1007/s11837-016-2177-6
2. Y. Bai, G. Wagner, and C. B. Williams, (2015)"Effect of Bimodal Powder Mixture on Powder Packing Density and Sintered Density in Binder Jetting of Metals."
3. Bailey, A. C., Merriman, A., Elliott, A., & Basti, M. M. (2016). Preliminary Testing of Nanoparticle Effectiveness in Binder Jetting Applications. Oak Ridge National Laboratory (ORNL), Oak Ridge, TN (United States). Manufacturing Demonstration Facility (MDF).

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