Optimization of the De-Bind Cycle of Sinter-Base Additive Manufactured 17-4 Components

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Abstract:

Sinter-based additive manufacturing (S-BAM), of which Binder Jet AM (BJAM) is one approach, is quickly becoming recognized as one of the most desirable methods to produce high-volume 3D printed components and to develop new 3D printable materials. Although the S-BAM technique of printing has been available for a while, the optimal processing parameters, such as the time to de-bind and sinter, must be better understood for the full advantage of this method to produce high-volume components to be realized.

The first step in the optimization of the process is to understand the binder and its function. Thermal Gravimetric Analysis (TGA) results are used to determine how the binder breaks down and at what temperature the optimal de-binding process should be performed. Along with this, the functionality of the binder will be considered to determine the importance of thermal ramp rates.

Through time-stop studies, printed 17-4 stainless steel components of varying thicknesses will be analyzed for binder removal. This provides an understanding of the de-binding steps as a function of time and allows for the optimal time for de-binding as a function of the components thickness to be determined. This information can then be used to optimize the BJAM process, advance production rates, reduce cost, and improve product quality.

Background:

Sinter-based additive manufacturing (S-BAM), specifically Binder Jet Additive Manufacturing (BJAM), is not a new technology. For a long time, the printing of metal by BJAM has been considered the "ugly stepchild" of the metal printing world. Over the past few years, this has changed as the desire to print reactive metals and high-volume components has come to the forefront of the industry. BJAM of metal has a much higher throughput than energy-based technologies and can print materials that cannot be welded.

As Gonzalez-Gutierrez et. al. show in Figure #1 (Gonzalez-Gutierrez, 2018), the S-BAM process fits well within the already existing MIM process. Metal Injected Molding (MIM) producers have been the quickest to adopt S-BAM to produce complex components due to these similarities.